MODERN PLASTICS

ENCYCLOPEDIA

ISSUE

SEPTEMBER

1957

MODERN PLASTICS ENCYCLOPEDIA ISSUE

SEPTEMBER 1957

Volume 35, Number 1A

Modern Plastics Executive and Editorial Offices: 575 Madison Ave., New York 22, N. Y.

Modern Plastics published monthly by Breskin Publications, Inc., at Emmett St., Bristol, Conn. Modern Plastics Encyclopedia Issue published as second issue in September by Plastics Catalogue Corp., at Emmett St., Bristol, Conn. Subscription rates (including Modern Plastics Encyclopedia Issue), payable in U. S. currency: In United States, its possessions, and Canada, 1 year $7, 2 years $12, 3 years $17; all other countries, 1 year $20, 2 years $35, 3 years $50. Single copies 75¢ each (Show issue, $1.00, Encyclopedia Issue $3.00) in the U. S., its possessions, and Canada; all other countries $2.00 (Show issue $2.50, Encyclopedia Issue $6.00). Modern Plastics Encyclopedia Issue copyright 1957 by Plastics Catalogue Corp. All rights reserved. Nothing that appears in the Modern Plastics Encyclopedia Issue may be reprinted wholly or in part without first securing special permission. Printed in U.S.A. by Hildreth Press, Inc., Bristol, Conn.
*Reg. U.S. Pat. Off.

FOREWORD

As a reflection of the expansion which the plastics industries experienced during the past year, the scope of information offered in the 1957 Modern Plastics Encyclopedia Issue has been considerably broadened to take in the latest in materials, processing, and application developments. Every effort has been made as well to present this wealth of information in such a manner as to facilitate the job of selecting specific data quickly and easily.

The popular Plastics Properties Chart, for example, which seems to grow bigger every year, has not only been revised to include new materials, but has been completely redesigned in the form of a bar chart to increase its value as a working tool for the industry. By supplementing numerical values, these bars serve as a visual guide to the user seeking materials with specific properties.

With an eye to the new developments that have taken place within the past year and the new technical language that has come into being, both the Primer of Plastics and the Plastics Glossary have been expanded.

The Resins and Molding Compounds section has also come in for several changes this year. Every article has been reviewed and up-dated by authoritative experts in each field, with special emphasis being placed in those areas where technological developments have been breaking at a fast and furious pace. The articles on styrene copolymers, nylons, and ethylene polymers, among others, stand out in this respect.

Again reflecting the interests of the plastics industries, an entirely new section on Foamed Plastics has been incorporated in this year's Encyclopedia.

In the Engineering and Methods section, readers will find a series of tables that offer a concise and handy guide to the molding characteristics of the individual materials

covered in each of the accompanying articles. Another innovation in this section is the inclusion of a set of articles surveying the basic theories of injection molding, compression molding, and extrusion. And in the Fabricating and Finishing section, as well as in the Machinery and Equipment section, recent developments have been digested in outline form to provide a quick review of the year's activities.

Other special interests which occupied the plastics industries during the past year, from new techniques for preforming fibrous glass to instrumentation, are individually covered in appropriate articles. The Directory Section, as always, carries an authoritative listing of manufacturers, molders, suppliers, etc., as well as a list of Trade Designations.

In using the 1957 Encyclopedia Issue, readers are advised to refer first to the key Index, beginning on page 30. As a further guide, an Index of Advertisers whose products and/or services are related to the subject matter of individual sections can be found at the beginning of each section.

Readers should also bear in mind the availability of Modern Plastics Encyclopedia's editorial and advertising staffs as a source for additional information on any subject covered in the editorial or advertising pages of this issue. Inquiries addressed to the Readers Service Department will be given prompt attention. To aid in their processing, it is recommended that readers include with their inquiries the page number of the editorial page or the advertising page on which they are seeking additional information.

CHARLES A. BRESKIN, *Chairman of the board*

A BRESKIN Publication

Chairman of the board
Charles A. Breskin

President and publisher
Alan S. Cole

Editorial director
Dr. Gordon M. Kline

Editor-in-chief
Hiram McCann

Editor
Joel Frados

Managing editor
A. Paul Peck

Engineering editor
Dr. James F. Carley

Associate editors
Lynne Bortnick Harrison
Eileen Weiss
Ann K. Cook

Editorial consultant
R. L. Van Boskirk

Directory editor
Phyllis Kahn

Art director
Donald R. Ruther

Treasurer
Beatrice Grove
Gertrude Binger, *assistant*

Circulation manager
Robert B. Birnbaum

Production staff
Daniel M. Broads, *director*
Bernard J. Farina
Jack Postelnek

Promotion
Philip W. Muller, *manager*

Business staff
New York 22, 575 Madison Ave
Tel., PLaza 9-2710
M. A. Olsen, *general manager*
P. H. Backstrom
B. W. Gussow
S. S. Siegel
R. C. Nilson
B. R. Stanton

Chicago 11, 101 E. Ontario St.
Tel., DElaware 7-0060
J. M. Connors
W. F. Kennedy
H. R. Friedman

Cleveland 22, 20310 Kinsman Rd.
Tel., SKyline 1-6200
R. C. Beggs

Los Angeles 48, 6535 Wilshire Blvd.
Tel., OLive 3-3223
J. C. Galloway

London S. W. 1, England
Panton House, 25 Haymarket
Tel., TRafalgar 3901
T. G. Rowden

Frankfurt am Main, Germany
Wittelsbacher Allee 60
Tel., 46 143/46 372
G. J. Linder

Member Audit Bureau of Circulations. Member Associated Business Publications.

Contents

Foreword 2
Acknowledgements 6
Primer of Plastics 10
Plastics Glossary 16
Index 30

Resins and Molding Compounds—p. 40

Advertisers: Resins and Molding Compounds 40
Acrylics 86
Amino Resins 91
Cellulosics 96
Cold Molded Organic Plastics 102
Coumarone-Indene, Petroleum, and Polyterpene Resins 103
Epoxy Resins 105
Ethylene Polymers 112
Fluoroethylene Polymers 119
Furane Resins 121
Inorganic Plastics 122
Ion Exchange Resins 123
Isocyanate Resins 126
Natural Resins 129
Nylons (Polyamides) 130
Phenolics 135
Polyester (Alkyd) Resins 140
Protein Plastics: Zein, Casein 146
Silicones 148
Styrene Polymers and Copolymers 152
Styrene Alloys 156
Synthetic Rubber and Rubber Derivatives 159
Vinyl Polymers and Copolymers 164
Rigid Vinyls 171
Vulcanized Fibre 174
Resins for Coatings 175
Resins for Adhesives 180

Foamed Plastics—p. 334

Advertisers: Foamed Plastics 333
Foamed Plastics 334
Foaming Agents 359

Chemicals for Plastics—p. 364

Advertisers: Chemicals for Plastics 363
Organic Intermediates 364
Colorants for Plastics 367
Destaticizers 374
Mold Release Agents 376
Stabilizers 377
Plasticizers 381
Solvents 385

Film and Sheeting—p. 434

Advertisers: Film and Sheeting 433
Film and Sheeting Survey 434
Laminated Materials 442
Decorating Film and Sheeting 444

Fillers and Reinforcements—p. 468

Advertisers: Fillers and Reinforcements 467
Fillers for Molding Compounds 468
Fibrous Glass Reinforcements 472
Synthetic and Cellulosic Fibers 478
Asbestos Reinforcements 482

Laminates and Reinforced Plastics—p. 506

Advertisers: Laminates and Reinforced Plastics 505
Laminates and Laminating 506
Machining Laminates 514
Molding Reinforced Plastics 518
Preforming Fibrous Glass 523
Sandwich Constructions 525

Technical Data—p. 554

Plastics Properties Chart ..... Facing 554
Statistics of the Industry 555
Foamed Plastics Chart 556
Films Chart 559
Adhesives Chart 564
Coatings Chart 572
Fibers Chart 580
Laminates Chart 586
Low-Pressure Laminating Resins Chart 590
Plasticizers Chart 598
Bibliography of Books and Magazines 615

Engineering and Methods—p. 619

Advertisers: Engineering and Methods 619
Injection Molding 650
Compression and Transfer Molding 681
Extrusion 704
Thermoplastic Sheet Forming 736
Plastics Tooling 743
Casting Plastics 747

Fabricating and Finishing—p. 818

Advertisers: Fabricating and Finishing 817
Adhesive Bonding 818
Machining Thermoplastics 824
Decorating Molded Plastics 828
Metalizing 834
Welding Plastics 838

Machinery and Equipment—p. 864

Advertisers: Machinery and Equipment 864
Instrumentation 890
Equipment for Injection Molding 893
Equipment for Compression and Transfer Molding 896
Equipment for Extrusion 898
Equipment for Laminating 901
Equipment for Coating 903
Equipment for Calendering 905
Equipment for Mold Making 907
Equipment for Compounding and Coloring 912
Equipment for Preforming 918
Equipment for Heat-Sealing 924
Equipment for Reinforced Plastics 926

Directory—p. 1017

Index to Directory 1018
Alphabetical List of Manufacturers and Addresses 1123
Index to Advertisers 1150

ACKNOWLEDG

No volume of the scope of Modern Plastics Encyclopedia could be prepared without the complete cooperation of the industry which it serves. As always, such cooperation was cheerfully extended for the 1957 Edition. The Editors wish, therefore, to express their sincere thanks to the authors whose names appear on various articles, as well as to the companies and individuals listed below for supplying information, illustrations, and helpful suggestions.

Achhammer, B. G.

Acryvin Corp. of America—Carl L. Shapiro

Adhesive Products Corp.—J. E. Conrad

Adhesive Products, Inc., The—W. F. Harrison

Allied Resinous Products, Inc.—N. K. Anderson

Ambassador Plastics and Mfg. Co.—L. Corwin

Amercoat Corp.—L. R. Smith

American Agile Corp.—C. F. Freedman

American-British Chemical Supplies, Inc.—H. K. Vanderhoef

American Cyanamid Co.—H. J. West, Ted Wennergren, Norman Prince

American Hard Rubber Co.—G. H. Reed

American Insulator Corp.—M. F. Lloyd

American Latex Products Corp.—George Morris

American Marietta Co.—D. V. Redfern, W. E. Van Vactor

American Mineral Spirits Co.—R. M. Pegram

American Products Mfg. Co.—H. A. Levey

American Pyroxylin Corp.—M. Goldberg

American Reinforced Sales—H. B. Sait

American Viscose Corp.—Charles R. Shaffer

Anchor Plastics Co., Inc.—Robert Marx

Angier Products, Inc.—Harold J. Thoma

Archer-Daniels-Midland Co.—R. S. Mathews, C. S. Stryker

Argus Chemical Corp. Norman L. Perry

Armour and Co.—(Adhesive Div.) L. B. Lane, (Chemical Div.) Harry J. Delfs, Jr.

Armstrong Products Co.—F. E. Harrison

Arnold, Hoffman & Co., Inc.—Kenneth W. Bean

Atlas Mineral Products Co., The—Gerald F. Gilbert, Jr.

Bakelite Co., Div. of Union Carbide Corp.—Val Reisig, Don Masson, David Given, Arthur Falconer, H. F. Robertson

Baker Castor Oil Co., The—J. F. O'Brien

Barrett Div., Allied Chemical & Dye Corp.—Joan Butler

B. B. Chemical Co.—K. W. Winslow

Bjorksten Research Laboratories Inc.—Johan Bjorksten

Bolta Products, Div. of General Tire & Rubber Co.—Horace N. Grover

Bond Adhesives Co.—Milton Spielvogel

Borden Co., The—J. S. Brown, D. F. Gould

British Resin Products Ltd.—S. E. Bolam

Brown Rubber Co., Inc.—W. H. Hippensteel

Brunelle, Charles, Co., The—Norman S. Fenichel

Buckstaff Co., The—Frank C. Schultz

Cabot, Godfrey L., Inc.—Shirley G. Copithorne

Cadillac Plastic and Chemical Co.—Robert B. Jacob

Canadian Industries Ltd.—R. S. Sansone, R. K. Buhr

Carboline Co., Div., Acid & Alkali Resistant Cements & Finishes—C. Leutwiler

Carpenter, L. E. & Co., Inc.—George Lucas, Jr.

Cast Optics Corp.—William E. Chapman

Catalin Corp. of America—R. A. Woodard

Celanese Corp. of America—Paul W. Kinney, Thomas J. Welsh, Harriet Raymond

Chemical Coatings and Engineering Co., Inc.,—Karl Bennung, Jr.

Chemical Process Co.—J. J. Bogner

Chemical Products Corp.—Bronson B. Bump

Cheney Bros.—Ward Cheney

Ciba Co., Inc.—Frank E. Pschorr, Donald M. Joseph

Coast Mfg. & Supply Co.—John L. Stief

Columbia-Southern Chemical Corp.—Wm. R. Dial

Continental Can Co., Inc.—Fred B. Shaw

Continental-Diamond Fibre Div., The Budd Co., Inc.—S. W. Place, E. O. Hausmann, O. Thomas

Contour Extrusion Co.—J. Dukess

Corn Products Sales Co.—C. J. McDowell

Crownoil Chemical Co., Inc.—Murray B. Hundert

Cryovac Co., Div. W. R. Grace—Robert D. Lowry

Curtiss Wright Corp.—William Kaiser

Davis, Joseph, Plastics Co.—Morton Davis

Decar Plastic Corp.—T. Walter Noble

Dewey and Almy Chemical Co.—Charles M. Fosgate

Diamond Alkali Co.—R. G. Richards, M. J. Skeeters

Dow Chemical Co., The—Don Stark, R. W. Theobald, L. Barnett, Gordon B. Thayer, Paul Filter, Harold Cook

Dow Corning Corp.—Maurice C. Hommel

du Pont, E. I. de Nemours & Co., Inc.—L. June Gundrum, Jack Isbell, F. W. Miller, Jr., Charles Booz, L. T. Sherwood, Jack Burchenal, E. T. Darden

Durethene Corp.—Carl A. Raabe

Durez Plastics Div., Hooker Electrochemical Co.—C. R. Simmons

Eastman Chemical Products, Inc.—George W. Wernz, C. R. Lee, Thos. P. Johnston, Dennis C. Guthrie

Eastman Kodak Co.—V. M. Howe, C. E. Lyons

Electronic Mechanics, Inc.—F. B. Du Vall

Elm Coated Fabrics Co., Inc.—M. H. Grant

Emerson & Cuming, Inc.—William R. Cuming

Emery Industries, Inc.—A. C. Fusaro

Emulsol Chemical Corp.—C. F. Fuchs

Enjay Co., Inc.—C. J. Bitzer, E. R. Littmann

Esso Standard Oil Co.—W. C. Sussky

Extruders, Inc.—J. A. Croft

Fairchild Guided Missiles Div., Fairchild Engine and Airplane Corp.—C. R. Lemonier

GEMENTS

Farley & Loetscher Mfg. Co.—R. J. Sullivan, Jr., D. M. Neyens

Farrington Texol Corp.—Bradford S. Ritchie

Federal Adhesives Corp.—M. E. Stern

Ferro Corp.—L. Dow Moore

Fiber Glass Div., Ferro Corp.—W. G. Cole, Jr.

Filmwood Corp.—Kenneth A. Whitecar

Firestone Industrial Products Co.—H. L. Ebert

Firestone Plastics Co., Div. of The Firestone Tire & Rubber Co.—B. K. Lyckberg, T. A. Henry, M. Bachner

Fisher Scientific Co.—George D. Welch

Flexible Products Co.—R. T. Henson

Foam King, Inc.—H. Dash

Food Machinery and Chemical Corp.—Daniel J. Donnelly

Foremost Food & Chemical Co., El Dorado Div.—J. W. Howell

Formica Co., The—J. C. Pitzer, L. Francisco

Foster Grant Co., Inc.—Richard B. Bishop, John W. Labelle

France, Campbell & Darling, Inc.—Wallace C. France

Fuller, H. B., Co.—Walt Meyer

Furane Plastics, Inc.—John Delmonte

Garfield Mfg. Co.—John N. Campbell

Garlock Packing Co., The—R. C. McGonigal

General Aniline & Film Corp.—J. Werner

General Electric Co.—William J. Connolly, J. J. Moran, R. J. Prochaska

General Mills, Inc.—W. L. Minarik

General Plastics Corp.—Richard H. Erlewine

General Tire & Rubber Co., The—W. T. Reilly, L. W. Reeves

Gering Products, Inc.—Wayne M. Schrag

Gill, M. C., Corp.—M. C. Gill

Glidden Co., The—Robert R. Augsburger, Walter J. Maker

Goodrich, B. F., Chemical Co.—J. A. Huber, S. F. Korenchan, W. E. Manring

Goodrich, B. F., Co., The—J. H. Field, Jr., John F. Anderson

Goodyear Aircraft Corp.—B. D. Raffel

Goodyear Tire & Rubber Co., Inc., The—W. B. Kelley, R. S. Sanders, E. F. Gibbons, W. F. Diffenderfer, E. J. Dunlavy, Jr.

Grant Chemical Co.—Allen W. Schmidt

Harchem Div., Wallace & Tiernan Inc.—Frank H. Smart

Harte & Co., Inc.—Philip Miller

Harwick Standard Chemical Co.—D. F. Behney

Haskelite Mfg Corp.—Emory W. Stoner

Haveg Corp.—C. R. Runk

Hercules Powder Co., Inc.—Emmett E. Hixon, Elizabeth B. Alden, Philip A. Belk

Hewitt, C. B., & Bros., Inc.—R. J. Hanlon

Heyden Chemical Corp.—T. R. Aalto

Hood Sponge Rubber Co.—F. D. Ortscheid

Hooker Electrochemical Co.—Wallace H. Kinz, A. V. Chinnock

Houghton Laboratories, Inc.—John M. Jewell

Howards & Sons (Canada) Ltd.—T. H. G. Michael

Hughes Glue Co.—Robert T. Hughes

Innes, O. G., Corp.—R. O. Innes

Interchemical Corp.—Paul O. Blackmore

Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co.—Russell Baker

Isocyanate Products, Inc.—Jerold B. Smith

Jefferson Chemical Co., Inc.—L. J. Garrison

Jones-Dabney Co.—E. T. Dawson

Kenrich Corp.—John Ware

Keer, R. W., Plastic Co.—F. W. Stromer

Kessler Chemical Co., Inc.—John P. Hardiman

Keystone Refining Co., Inc.—Eleanor S. Elliott

Knoedler Chemical Co.—Karl Loos

Kolker Chemical Corp.—E. C. Missbach

Koppers Co., Inc.—Paul E. Cornyn, George Van Gundy, D. F. Over

Krylon, Inc.—Elmore E. Kayser

Lithgow, James, Co.—Chas. E. Logan

L. O. F. Glass Fibers Co.—W. L. Whitcomb

Loven Chemical of California—Raymond B. Seymour

Lucidol Div., Wallace & Tiernan, Inc.—C. H. Rybolt

Lupton, John Mather, Co., Inc.—Fred Brewster, Ralph Sadler

Luzerne Rubber Co., The—W. Murray Gall

Marblette Corp., The—M. Hilrich

Marbon Chemical, Div. of Borg-Warner Corp.—Howard H. Irvin

Masonite Corp.—J. H. Mein

Mathieu, Charles, & Co.—Charles Mathieu

Melamine Plastics Corp.—Paul A. Bury

Mellon Institute of Industrial Research—W. C. Hunt

Mesa Plastics Co.—Felix C. Karas

Midland Adhesive and Chemical Corp.—I. A. Schulist

Minnesota Mining & Mfg. Co.—J. A. Jupa, R. K. Humke, Ronald L. Anderson, L. W. Cornell, George W. Crain, Rod Leonard

Miracle Adhesives Corp.—E. R. Falkenburg

Mobay Chemical Co.—J. G. Zack

Mol-Rez Corp.—P. B. Herman

Mono-Sol Corp.—E. M. Kratz

Monsanto Chemical Co.—Charles P. O'Donnell, Gertrude Bailey, Rodney M. Huck, Norbert Platzer, M. C. Throdahl, E. F. Jackson, Martin L. Svehla, J. Holt

Montrose Chemical Co.—Samuel Rotrosen

Muehlstein, H., & Co., Inc.—T. J. Sherga

Munray Products, Inc.—Vernon K. Jack

Mycalex Corp. of America—A. J. Monack, J. H. DuBois

Narmco Resins & Coatings Co.—Ollie Holt

National Adhesives, Div. of National Starch Products Inc.—William J. East

National Casein Co.—Thomas H. Cook

National Lead Co.—P. W. Rizzo

National Plastic Products Co., The—James Richards, T. E. McGoury

National Polymer Products, Inc.—Conrad H. Busch

National Vulcanized Fibre Co.—R. F. Bogart, J. Macadam

Natvar Corp.—R. C. Lorentz

Naugatuck Chemical—W. F. Lavelle, E. S. Ebers

Neville Chemical Co.—E. Glenn Isenberg, W. J. Wald

Newport Industries, Inc.—John H. Holzberger
New York Quinine & Chemical Works, Inc., The—W. A. Thawley
Nixon Nitration Works—I. O. Kenen
Nopco Chemical Co., Inc.—E. G. Ackerman
Nova Chemical Corp.—G. A. Wolff

Olin Film Div., Olin Mathieson Chemical Corp.—C. D. Mollo
Osborn, C. J., Co.—C. F. Silleck

Paisley Products Inc., Div. of Morningstar, Nicol, Inc.—A. G. Cserne
Pan American Chemicals Corp.—Frank J. Smith
Pantasote Co., The—Henry W. Wyman
Parkwood Laminates, Inc.—P. B. Leverette
Parks and Co.—Lloyd E. Parks
Parsons & Whittemore, Inc.—C. Silvis
Penola Oil Co.—L. T. Morrow, George F. Heil
Perry-Brown, Inc.—Gordon G. Moffitt
Phillips Petroleum Co.—C. W. Wolfe, G. T. Leatherman, George Wash, R. M. Wallace
Pierce & Stevens, Inc.—George H. Askin
Pioneer Latex & Chemical Co.—Edward H. Robbins
Pittsburgh Coke & Chemical Co.—Duncan J. MacLennan
Pittsburgh Plate Glass Co.—E. W. Moffett, H. L. Gerhart, E. M. Penney
Plastex Process Co.—Clifford Jordan
Plastic Film Corp.—T. A. Lancaster
Plastics Engineering Co.—Ralph T. Brotz
Plax Corp.—C. N. Sprankle
Polymer Chemical Co.—H. N. Waldman
Polymer Corp. of Pennsylvania, The—Conrad H. Busch
Polymer Industries Inc.—John W. Foster, Jr.
Presto Plastic Products Co., Inc.—J. P. Frank
Publicker Industries Inc.—Frank E. Bennett
Pyroxylin Products, Inc.—W. C. Ashley

Raffi and Swanson, Inc.—R. O. Fernandez
Rand Rubber Co.—L. H. Rand
Reliance Plastic & Chemical Corp.—Fred Levine
Reichhold Chemicals, Inc.—Mark K. Pinkerman
Resin Industries, Inc.—Allen W. Schmidt
Resistoflex Corp.—C. W. Smythe, B. M. Walker
Respro Div., The General Tire & Rubber Co.—W. H. Young, Jr.
Reynolds Chemical Products Co., The—James W. Hull
Reynolds Metals Co.—R. L. Moore
Rezolin, Inc.—L. R. Miller
Richardson Co., The—J. C. Richardson
Richardson Moulded Products Ltd.—W. R. Douglas
Rogers Corp.—T. H. Johnston, Jr.
Rohm & Haas Co.—M. Kilpatrick, Robert P. Goodale, Burnap Post, Colin C. Campbell
Ross & Roberts Sales Co., Inc.—Eleanor Hans
Rostone Corp.—M. G. Knoy
Rubatex Div., Great American Industries, Inc.—K. E. Balliet, King Daywalt
Rubber and Asbestos Corp.—Bernard Gould
Rubber Corp. of America—A. E. Young
Russell Reinforced Plastics Corp.—Harry J. Friedman

Schwartz Chemical Co., Inc.—A. A. Schwartz
Seiberling Rubber Co.—C. J. Figenscher
Semet-Solvay Petrochemical Div., Allied Chemical & Dye Corp.—Wm. E. Schwarz
Shawinigan Resins Corp.—Ralph W. Poole, Jr.
Shell Chemical Corp.—F. S. Swackhamer
Sherwin-Williams Co. ,The—K. R. Brown, C. H. Carlson, H. F. Schwarz
Shoe Form Co., Inc.—G. N. Tutton
Sierracin Corp., The—J. E. Slatky
Silicones Div., Union Carbide Corp.—G. F. Brown
Slomons Laboratories, Inc.—Ira Slomon, Jr.
Sonneborn, L. Sons, Inc.—R. K. Rhodes
Spaulding Fibre Co., Inc.—R. B. Green
Specialty Resins Co.—E. A. Lasher
Spencer Chemical Co.—E. Stollenwerk, M. Stringfellow, T. O. Kresser
Spraylat Corp.—R. D. Oppenheim
Standard Oil Co. of California—F. L. Craise
Standard-Toch Chemicals, Inc.—H. F. Boehlert
Stanley Chemical Co., The—A. B. Sherry
Stevens, J. P., & Co., Inc.—N. B. Gobeil
F. J. Stokes Corp.—J. Gordon Seiter
Stoner-Mudge, Inc.—R. B. Wilson
Strux Corp.—Paul John Witte
Sullivan Chemicals Div., Sullivan Varnish Co.—W. A. Hanan
Styrene Products Ltd.—E. M. Hunt
Surprenant Mfg. Co.—E. M. Quill
Swift & Co.—E. R. Paul, G. G. Bixler
Sylvan Plastics, Inc.—Edwin F. James
Synco Resins, Inc.—A. E. Moyer
Synthetic Products Co.—R. J. O'Hara
Synvar Corp.—L. F. Bornstein

Taylor Fibre Co.—John B. Huff
Textileather Div. of The General Tire & Rubber Co.—E. G. Hamway
Thermaflow Chemical Corp., Div., Atlas—Richard F. Doyne
Thiokol Chemical Corp.—Gertrude Levy

Union Carbide Corp.—Elizabeth Culberson
Union Oil Co. of California—F. H. Ott, J. J. Lamb
Union Paste Co.—A. B. Crowell, Jr.
United States Gasket Co.—C. M. Hobson
U. S. Industrial Chemicals Co.—Philip Gisser
United States Rubber Co.—W. N. Chandler, W. Thompson
United States Stoneware Co., The—D. F. Siddall

Valite Corp.—T. R. McElhinney
Varcum Chemical Corp.—R. D. McDonald
Velsicol Chemical Corp.—Edward B. Lukas
Virginia-Carolina Chemical Corp.—George J. Allen
Visking Co., Div. Union Carbide Corp.—James F. Bernard

Warwick Chemical Co., Div. Sun Chemical Corp.—H. B. Goldstein
Watertown Mfg. Co., The—H. R. Sjostedt
Watson-Standard Co.—Walter J. Kaufman
Western Coating Co.—Franklin B. Evans
Westinghouse Electric Corp.—M. F. Hertel, William A. Hice
Whittaker, Clark & Daniels, Inc.—A. J. Gitter
Williamson Adhesives, Inc.—Leonard F. Humphrey
Wilmington Fibre Specialty Co.—H. M. Romig
Wilross Products Co.—W. L. Rossin
Witco Chemical Co.—W. F. Twombly
Witte, John H., & Sons—W. A. Witte
Woodall Industries Inc.—O. H. Pelham
Wyandotte Chemicals Corp.—John C. Worrell

Xylos Rubber Co.—Frank G. Phillips

Zenith Aircraft Div. of Zenith Plastics Co.—Melvin Dauber, Frank E. Wallis
Zinsser, William, & Co., Inc.—Weaver R. Clayton

INDEX OF AUTHORS

Adams, R. G., "Preforming Fibrous Glass," p. 523.
Allen, Henry E., "Applications: Open Cell Foamed Vinyls," p. 334.

Baker, N. G., "Solvents," p. 385.
Bancroft, Robert, "Instrumentation," p. 890.
Baum, B., "Vinyl Polymers and Copolymers," p. 164.
Beattie, John O., "Casting Acrylics," p. 747.
Blomquist, R. F., "Resins for Adhesives," p. 180.
Bockhoff, F. J., "Welding Plastics," p. 838.
Bogart, Frank L., "Plastics Tooling," p. 743.
Brown, R. W., "Synthetic Rubber and Rubber Derivatives," p. 159.
Bunn, L. Thomas, "Extrusion of Tetrafluoroethylene," p. 724.

Burck, R. C., "Isocyanate Resins," p. 126.
Butzko, Robert L., "Thermoplastic Sheet Forming," p. 736.

Calsibet, R. A., "Resins for Coatings," p. 175.
Carlyon, George, "Machining Thermoplastics," p. 824.
Champney, Jr., E. D., "Polytetrafluoroethylene," p. 119.
Chapman, Frank M., "Compression Molding Tetrafluoroethylene," p. 694.
Coughlin, William J., "Injection Molding Special Styrenes," p. 677.
Courtney, R. P., "Foamed Phenolic," p. 352.

Dash, H., "Applications: Closed Cell Foamed Vinyls," p. 337.
Delmonte, John, "Furane Resins," p. 121.
De Young, Delbert N., "Extrusion of Tetrafluoroethylene," p. 724.
Douglas, Harry T., "Molding Reinforced Plastics," p. 518.
Dubois, J. H., "Glass Bonded Mica and the Ceramoplastics," p. 122.
Dudley, J. R., "High-Pressure Laminates: General Background," p. 506.

Ebelhare, George A., "Machining Laminates," p. 514.
Ecenbarger, G. R., "Equipment for Laminating," p. 901.
Edberg, Edwin A., "Expandable Polystyrene," p. 347.
Elliot, P. M., "Styrene Alloys," p. 156.
Epstein, George, "Epoxy Resins," p. 105. (Due to a printer's error, Mr. Epstein's company affiliation and copyright notice were inadvertently omitted from his article. Mr. Epstein is head of Research and Development Group, Structural Plastics Dept., Aerojet-General Corp., Azusa, Calif., and an Instructor in Resins and Adhesives for Engineering Extension, Univ. of Calif., Los Angeles, Calif. All copyright rights on Mr. Epstein's article are reserved by the author.)
Ericksen, P. H., "Injection Molding Cellulosics," p. 658.
Erickson, W. O., "Polyester (Alkyd) Resins," p. 140.

Firth, F. G., "Potting and Encapsulation of Electrical Components," p. 753.
Freygang, G. G., "Injection Molding Acrylics," p. 656.
Folsom, Allan G., "Extrusion of Polyvinyl Chloride," p. 727.

Gerstin, Harry, "Techniques: Foamed Polyurethanes," p. 341.
Ginsler, V. W., "Polyester (Alkyd) Resins," p. 140.
Glavis, F. J., "Acrylics," p. 86.
Gooch, Kendrick J., "Equipment for Calendering," p. 905.
Goodwin, Paul A., "Silicones," p. 148.
Guzzetti, A. J., "Compression Molding Phenolics," p. 698.

Hilrich, Max, "Plastics Tooling," p. 743; "Thermosets, Cast," p. 750.
Holt, C. R., "Injection Molding Special Styrenes," p. 676.
Hoover, C. E., "Fibrous Glass Reinforcements," p. 472.
Houston, J., "Ziegler-Process," p. 670.
Howland, L. H., "Synthetic Rubber and Rubber Derivatives," p. 159.

Jargstorff, G. W., "Injection Molding Branched Polyethylenes," p. 666.
Jahns, Jr., F. William, "High-Pressure Laminates," p. 510.
Jupa, J. A., "Trifluorochloroethylene," p. 120, and "Extrusion of Trifluorochloroethylene," p. 712.

Kaufman, Albert A., "Equipment for Extrusion," p. 898.
Kaufman, W. J., "Plastisol Molding," p. 760.
Kauppi, T. A., "Silicone Mold Release Agents," p. 376.

Laaff, George S., "Rigid Sheets for Thermoforming," p. 440; "Decorating Film and Sheeting," p. 444.
Landall, A. P., "Phenolics," p. 135.

Macadam, J., "Vulcanized Fibre," p. 174.
MacDermott, C. P., "Extrusion of Acrylics," p. 709.
Mack, Gerry P., "Stabilizers," p. 377.
Malone, J., "Rigid Vinyls," p. 171.
Mark, R., "Balsa Wood," p. 527.
Markhoff, Charles E., "Introduction to Compression Molding," p. 681.
Marshall, A., "Honeycomb," p. 526.
Marshall, W. W., "Applications: Foamed Polyurethanes," p. 339.
Massey, D. J., "Foaming Agents," p. 359.
McCabe, R. F., "Styrene Alloys," p. 156.
McCallum, W. A., "Luminous Pigments for Plastics," p. 373.
McLanahan, R. P., "Injection Molding Special Styrenes," p. 674.
Moyer, Robert R., "Injection Molding Polystyrene," p. 671, and "Injection Molding Special Styrenes," p. 675.
Moylan, J. J., "Compression Molding Alkyds," p. 683.

Neeley, Glen W., "High-Pressure Laminates: General Background," p. 506.
Neumann, J. A., "Welding Plastics," p. 838.
Neuwirth, Edward H., "Flexible Molds for Casting Plastics," p. 758.
Nissel, Frank R., "Equipment for Extrusion," p. 898.

Paggi, Louis, "Injection Molding Nylon," p. 662.
Parks, Lloyd E., "Decorating Molded Plastics," p. 828.
Patton, Paul W., "Metalizing," p. 834.
Peacock, William H., "Colorants for Plastics," p. 367.
Pelikan, Rolf, "Equipment for Injection Molding," p. 893.
Percival, Robert W., "Ion Exchange Resins," p. 123.
Powers, P. O., "Coumarone-Indene, Petroleum, and Polyterpene Resins," p. 103.

Rathmann, D. M., "Zein," p. 146.
Rosato, D. V., "Asbestos Reinforcements," p. 482.
Rothman, G. G., "Injection Molding Vinyls," p. 678.

Saunders, J. H., "Isocyanate Resins," p. 126.
Schwarz, H. R., "Synthetic and Cellulosic Fibers," p. 478.
Scott, J. N., "Injection Molding Linear Polyethylenes," p. 669.
Segal, H., "Extrusion of Cellulosics," p. 715.
Seymour, Raymond B., "Fillers for Molding Compounds," p. 468.
Skeist, I., "Adhesive Bonding," p. 818.
Smith, J. Virgil, "Injection Molding Linear Polyethylenes," p. 669.
Snyder, J. A., "Cellular Polyethylene," p. 350.
Sollenberger, G., "Ziegler-Process," p. 670.
Sonneborn, Ralph, "Fibrous Glass Reinforcements," p. 472.
Sonneman, Eric O., "Non-silicone Mold Release Agents," p. 376.
Stabler, Robert E., "Extrusion of Tetrafluoroethylene," p. 724.
Stratton, Jr., E. Bowman, "Thermoplastic Sheet Forming," p. 736.
Sturken, R. C., "Equipment for Coating," p. 903.

Taft, George H., "Plasticizers," p. 381.
Thayer, Gordon B., "Injection Molding Special Styrenes," p. 673.
Theobald, R. W., "Expanded Polystyrene," p. 344.
Thomas, Islyn, "Equipment for Mold Making," p. 907.
Thompson, Jr., Wallace B., "Extrusion of Tetrafluoroethylene," p. 724.
Thompson, W. W., "Preforming Fibrous Glass," p. 523.
Tiley, R. A., "Compression Molding Urea Formaldehyde," p. 690.
Toll, Karel G., "Extrusion of Nylon 66," p. 717.
Trunk, E. J., "Extrusion of A-B-S Polymer Blend," p. 730.
Tucker, Helen F., "Acrylics," p. 86.

Von Toerne, T. R., "Extrusion of Polycaprolactam Nylon," p. 721.

Weill, Peter S., "Techniques: Foamed Vinyls," p. 338.
West, Herbert J., "Amino Resins," p. 91, "Compression Molding Melamine Formaldehyde," p. 686, and "Compression Molding Urea Formaldehyde," p. 690.
Weyer, D. E., "Foamed Silicones," p. 356.
Williams, Bill, "Injection Molding Vinyls," p. 678.
Winger, Alvin G., "Ion Exchange Resins," p. 123.
Witte, Dr. P. J., "Expanded Cellular Cellulose Acetate," p. 343.
Wolford, E. Y., "Injection Molding Special Styrenes," p. 675.
Wyart, John W., "Solvents," p. 385.

Ziegler. E. E., "Destaticizers," p. 374.

PRIMER OF PLASTICS

The accepted definition of plastics is: "a large and varied group of materials which consist of, or contain as an essential ingredient, a substance of high molecular weight which, while solid in the finished state, at some stage in its manufacture is soft enough to be formed into various shapes, most usually through the application, either singly or together, of heat and pressure."

Most plastics, with the exception of the cellulosics, which are chemically modified natural high polymers made from cotton, are produced by the synthesis from such natural resources as water, air, coal, salt, natural gas, etc. From these are derived the various chemicals and gases which are combined to produce the plastics materials. As an example, the raw materials for making polystyrene, one of the most important of the plastics, are coal and petroleum or natural gas. By a process of distillation, benzene is extracted from the coal; from the petroleum or natural gas is taken the gas ethylene. These two materials are then linked to form ethyl benzene which is dehydrogenated to styrene. With the aid of catalysts, heat, and pressure, thousands of styrene molecules polymerize, or link together, to form long chain-like molecules that clump into small granules of crude polystyrene. These grains are hot-worked and cut into small pellets called molding powder, the most common form in which plastics are supplied.

Because of the many source materials which the chemist has at his command, and because so many different combinations are possible, the family of plastics today encompasses a large—and still growing—number of members, all of which differ in properties and characteristics. If, for example, the ethylene gas used in producing polystyrene were combined with chlorine (from salt) and then polymerized, the result would be polyvinyl chloride—a very different plastic.

Major Sub-Divisions

Many combinations and many different materials are thus possible. Therefore, for purposes of simplification, most plastics can be classified under one of the 14 recognized basic family groups. These groups, in turn, can be *generally* further classified under one of two major sub-divisions—thermosetting or thermoplastics. A few plastics are in-between—they can be formulated either to be thermosetting or to be thermoplastic.

The thermosets, as the term implies, set or harden (cure) under heat into a permanent shape. An irreversible chemical reaction called cross-linking occurs; this reaction links the resin chains so that the molded piece is essentially one giant, three-dimensional molecule. Subsequent heating, though it may soften the structure somewhat, cannot restore the flowability that typifies the uncured resin. In this classification are such basic family groups as the aminos (melamine and urea), most polyesters, alkyds, epoxies, and phenolics.

The thermoplastics, on the other hand, soften when heat is applied and harden upon cooling. By alternate heating and cooling, they can be reshaped again and again (just as a cake of ice melts in the sun and the resulting water can be solidified into a different shape by freezing). Thermoplastics include styrene polymers and copolymers, acrylics, cellulosics, polyethylenes, vinyls, nylons, and fluorocarbons.

Alloying of plastics yields new types of materials with intermediate physical and chemical properties. Similarly, plastics can be combined with other materials to create a new end-product having the advantages of both. Important examples are the blends of styrene-acrylonitrile or styrene-butadiene resins and rubbers which exhibit the hardness and high heat resistance of the resin and the toughness and low brittle point of the rubber. By copolymerizing (polymerizing together) two monomers, products similar to the alloyed polymers can be obtained, often at less expense.

Types of Plastics

A brief summary of the various types of plastics materials available, their properties and applications, may help to give the layman some idea of the versatility which plastics have to offer and the extent to which they have already penetrated our daily lives.

AMINOS (Urea and melamine): Urea formaldehyde resin is derived from the reaction of urea (carbamide) with formaldehyde or its polymers. Consumers are probably most familiar with the cosmetic containers, buttons, and electric mixer housings molded of urea to take advantage of the material's solvent-, oil-, and grease-resistance, surface hardness, mar-resistance, color potential, and good electric insulating qualities. Less familiar is the use of urea in liquid form in adhesives for plywood and lumber core gluing and laminating, in textile and paper treating resins, and in surface coatings that provide marproof finishes. Melamine formaldehyde resin is classed as a synthetic resin derived from the reaction of melamine (prepared from dicyandiamide) with formaldehyde. In addi-

tion to its well-known use in the molding of high-grade dinnerware and tableware, melamine is also used for critical military parts, industrial and decorative household appliances, handles, buttons, and other products. As a laminating resin, it goes into the manufacture of shockproof laminates and decorative laminates for household and office use. Melamine resins are also used in the formulation of boilproof, durable adhesives, in leather tanning, in the treatment of textiles, and in the production of wet-strength paper.

POLYESTERS: By definition, a polyester is a resin composed of polymeric esters in which the recurring ester groups are an integral part of the main polymer chain. Unsaturated polyesters contain double bonds which permit cross-linking and hence conversion of the resin to a substantially infusible and insoluble product. While some polyesters are used for casting applications (e.g., aircraft glazing, potting of electrical components, buttons, etc.), the bulk of the resin is used in the so-called "reinforced plastics" products. Because the polyesters are easily handled liquids that can be cured easily and quickly to a solid material without any liquid or gases being evolved, they can be reinforced with fibrous glass, asbestos, synthetic fibers, etc., and molded (either with or without pressure and with or without heat) into complex shapes characterized by high-impact strength, light weight, good dimensional stability, and good electrical properties. Products being molded today of reinforced polyester resins include: building panels, electrical equipment parts, boats, aircraft components, tote boxes, chairs, laundry tubs, automobile bodies and other components, luggage, awnings, etc.

ALKYDS: An alkyd is a type of synthetic resin described as an oil-modified polyester resin. As surface coatings, the alkyds provide a tough, versatile, uniform, and economical finish. Alkyd moldings exhibit excellent dimensional stability and electrical characteristics and are being used as tuner boards, tube bases, automotive ignition parts, etc.

PHENOLICS: Made by reacting phenol with aldehydes, phenolics are strong, rigid, dimensionally stable materials, resistant to heat and a wide variety of solvents, and, most important, a nonconductor of electricity. Phenolic moldings find application as light plugs, electric switch boxes, washing machine agitators, vacuum cleaner parts, and camera cases among others. In liquid form, phenolic is used in the manufacture of industrial and decorative laminates, as a protective coating, and as an adhesive. The plywood industry, which uses almost 10% of all the phenolic resin manufactured, is the largest customer for phenolic resin adhesives. Phenolic resins also find volume use in thermal insulation and in the manufacture of brake bands, which further account for a large share of total usage.

POLYSTYRENE: Polystyrene is a water-white thermoplastic produced by the polymerization of styrene (vinyl benzene). The general-purpose materials offer such outstanding advantages as: light weight, availability in a wide range of colors as well as in crystal-clear, freedom from taste and odor, nontoxicity, and exceptionally good electrical properties over the whole range of frequencies in practical use. General-purpose materials are used in the molding of a wide range of products, from disposable packages and refrigerator parts to toys, housewares, wall tile, and signs and displays. More recently, a whole new group of styrene materials with specialized properties (e.g., heat-resistant styrenes, light-stabilized styrenes, glass-reinforced styrenes, etc.) have been made available. One of the most important of the new groups are styrenes that have been toughened by copolymerization with butadiene and/or acrylonitrile. These rugged copolymers are being molded into pipe fittings, wheels, helmets, valve parts, refrigerator parts, toys, etc., or extruded into pipe that is being widely used by the petroleum industry. Sheeting based on this material is being formed into automobile headliners and kick plates, typewriter cases, refrigerator door liners, tote boxes, trays, and a wide variety of functional and/or decorative housings.

ACRYLICS: Basically, acrylics constitute a family that comprises monomers and polymers of acrylic, substituted acrylics, and methacrylic acids, their salts, esters, and other derivatives, such as nitriles and amides. In the form of sheets and molding powders, the properties exhibited by the solid acrylic polymers, such as crystal clarity, high impact strength, ease of formability, and resistance to sunlight, weather, and most chemicals, have led to their widespread use in a range of military and civilian applications that includes: airplane canopies; radar plotting boards; signs and displays; light diffusers; industrial window glazing; shower enclosures; automotive parts (taillight and stoplight lenses, medallions, instrument panels, etc.); and control knobs, dials, and handles. Acrylic resins also play an important role in the formulation of paints, clear greaseproof paper coatings, adhesives, and coatings for leather finishing applications.

CELLULOSICS: The family of cellulosics comprise such a wide variety of materials, e.g., cellulose acetate, cellulose acetate butyrate, cellulose nitrate, cellulose propionate, ethyl cellulose, etc., that to explain and define each would take up considerably more space than is allotted here. To mention just two, however, cellulose acetate plastics are notable for their outstanding toughness and high-impact strength, and are used for toys, beads, cutlery handles, knobs, electrical parts, ladies shoe heels, and housings. In sheet form, cellulose acetate is widely used as a packaging material and for electric insulation and tape. The

primary physical properties of cellulose acetate butyrate are a hornlike toughness, high-impact strength, uniform texture, dimensional stability under normally varying conditions of temperature and humidity, and low moisture absorption. One of the large-volume applications for butyrate can be found in extruded pipe.

POLYETHYLENE: Basically, polyethylene is synthesized by the polymerization of ethylene at elevated temperatures and pressures in the presence of suitable catalysts. Conventional low-density polyethylene requires very high synthesis pressures (15,000 to 30,000 p.s.i.) and uses free radical catalysts, such as peroxides. The newer stiff, high-density polyethylenes are made at lower synthesis pressures, using coordination catalysts. There is still confusion as to just where the new polyethylenes (with their greater strength, stiffness, and heat resistance) will fit into the application picture. The conventional polyethylenes, with their flexibility, durability, light weight, resistance to moisture, excellent chemical resistance, and retention of strength at freezing temperatures, already have found a number of important markets. These include: molded housewares, film and sheeting for the building industry, the agricultural field, and the packaging industry; electrical insulation in the form of outer jackets for power cables, telephone lines, appliance wire, etc.; extruded pipe for farm, mine, and home uses; coatings for paper, aluminum foil, and other sheet materials; squeeze bottles and tubes; and extruded monofilaments.

VINYL: This family of plastics takes in a wide group of resins, e.g., polyvinyl acetate, polyvinyl acetals, polyvinyl alcohol, etc., the most important of which is polyvinyl chloride. Polyvinyl chloride is described as a thermoplastic material composed of polymers of vinyl chloride. It is a colorless solid with outstanding resistance to water, alcohols, and concentrated acids and alkalies. One of the initial uses of vinyl chloride resins—electrical insulation—is still an extremely large market today. In the form of film and sheet, vinyl chloride resins have also found a virtually inexhaustible market that already includes shower curtains, inflatables, vapor barriers, silo covers, and upholstery. Floor covering is also a big outlet as are extruded products. Most of these products are made of plasticized (softened) vinyl.

NYLON: Nylons are polymeric resins formed by the condensation of dibasic organic acids with diamines into linear chains containing amide groups. The various grades of nylons available (nylon 6, nylon 6/6, nylon 6/10, etc.) have several outstanding features in common: they are stiff, strong, tough, light, abrasion-resistant, have a low coefficient of friction, and are chemically and thermally resistant. Nylon is finding application in the form of molded gears and bushings, housings, cams, and aerosol bottles. The use of nylon as a jacket for wire and cables is already well-established, but newer extrusion applications, including the possibility of a tough nylon film for packaging uses are attracting attention.

OTHER RESINS: The FLUOROCARBONS, EPOXIES, and SILICONES are coming more and more into the picture. The fluorocarbons with their good thermal and chemical resistance, nonadhesiveness, low dissipation factor, and low dielectric constant, are finding use in such applications as corrosion-resistant pipe or as an insulating material. Epoxies are strong, light in weight, shrinkproof, and resistant to water and heat. They are used as surface coatings, in adhesives, in laminates, in castings (particularly in the tooling field and for potting of delicate electronic components). Reinforced with fibrous glass, they are finding important use for such structural and electrical applications as radomes, terminal boards, printed electronic circuits, aircraft skins, etc. The silicones contribute excellent weather, heat, and wear resistance to an end-product. Silicones exist in a wide range of physical forms, from simple fluids through greases and flexible rubbers to hard, durable resins of complex structures. Among their applications are silicone rubbers; molding compounds for use in gaskets, circuit breakers, etc.; laminating resins for instances where high-temperature operation is required; release agents; lubricants; adhesives; and coatings.

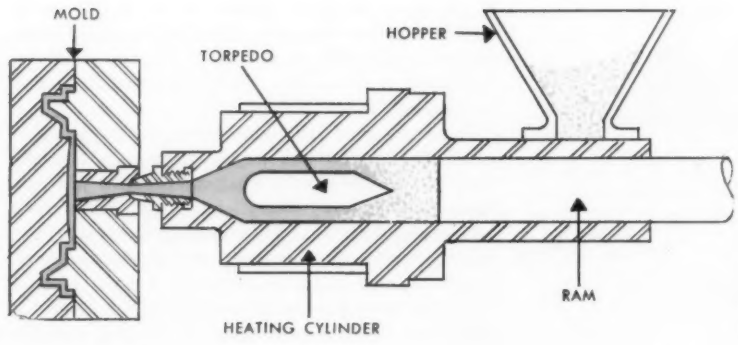
Processing Methods

Before they are processed, most basic plastics resins can be combined—compounded—with any one of a large range of modifying chemicals or reinforcing materials in varying proportions to achieve a given end result. Such additions can take the form of plasticizers (which soften the plastic and make it more flexible), stabilizers (which prevent degradation in the plastic when it is exposed to heat or light), fillers (which add bulk and reduce over-all costs), colorants (which add integral color to the processed plastic end-product), and reinforcing fibers (which improve impact strength, electrical properties, etc., of finished product). Solvents are used in plastics compositions to give the degree of temporary fluidity necessary to such operations as dipping, brushing, spraying, etc., and catalysts are often added to speed up the cure of a compound.

After compounding, the resultant plastics are supplied in convenient liquid, granular, and powdered forms to processors.

From granular or powdered form, they are softened and shaped by molding or extrusion. They can also be transformed into flexible film or sheeting by extrusion or calendering. Sheets in turn may be resoftened and shaped into contoured products.

In liquid form, the plastics are used as spray-on, dip-on, and brush-on coatings, or incorporated into lacquers, paints, and adhesives. Plastic-based



INJECTION MOLDING: Pellets of plastic resin (in color) feeding from hopper are melted in the heating cylinder and forced forward by the ram into the mold

bonding agents are among the best. Liquid plastics are also cast into sheets.

By mechanical mixing or by the addition of chemical blowing agents, liquid plastics resins can also be foamed into a cellular product for insulation, cushioning, floatation applications, etc.

Of these methods of processing, molding consumes the largest volume of material. Molding procedures are all based on the fact that, when the plastic is heated, it will melt to a viscous liquid that can be forced into a mold of desired shape, where it solidifies.

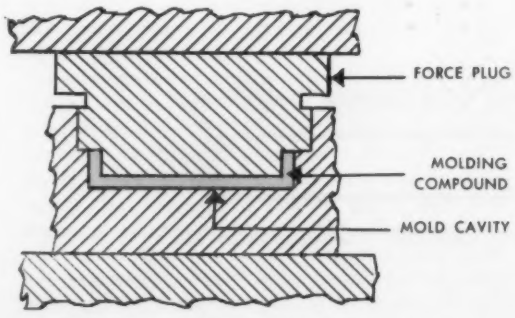
Injection Molding

Different molding processes have been developed to handle the specialized properties of the various plastics. Injection molding, for example, is the most commonly used method for producing thermoplastic end-products.

In injection molding, pellets are first fed from the hopper into the rear end of the heating cylinder where heating starts. With successive strokes of the injection ram the material is compacted and forced forward through the thin annular space between a heated "torpedo" in the center of the cylinder and the cylinder walls. There the material is melted. Soon it reaches the cylinder nozzle and is injected into the cold mold.

The fluid plastic completely fills the mold cavity, which is shaped to the contours of the finished product. When the plastic has cooled and solidified, the mold is opened and the finished piece, an exact image of the mold cavity, is ejected.

To speed up molding cycles and facilitate production, preplasticators are available. A preplasticator is simply an auxiliary heating cylinder which melts the granules and transfers the melt to the injection cylinder where it is further heated and held ready for injection.



COMPRESSION MOLDING: Plastic is pressed into cavity

Compression Molding

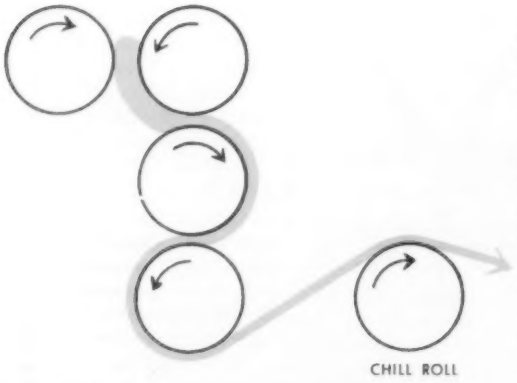
For molding the thermosetting plastics, the method most generally used is compression molding. The basic procedure is to place the molding compound (generally preheated) in the open mold cavity, close the mold, and then apply heat and pressure (through a downward-moving force plug) to the material until it softens and is forced to fill the mold cavity. In the closed mold, the material undergoes a chemical reaction that cross-links the polymer chains and thus hardens into a permanent shape. The mold is then opened and the solid piece is removed.

Transfer molding is a variation on compression molding in which the heat and pressure are applied to the molding material outside the mold. The fluid material is then forced through a series of channels (runners) from the external chamber to the mold cavity where final cure takes place.

Extrusion

For the production of continuous film, sheeting, rods, tubes, and other profile shapes (as distinguished from molded shapes), extrusion, another of the major processing divisions, is the method commonly employed.

In extrusion, the powdered or granular material is fed through a hopper at the rear of the unit into a heated barrel where it is plasticated by heat and working. The hot melt is then forced forward by a continuously revolving screw through the heating chamber and out through a shaping orifice or die, much as meat is forced through a grinder. As the plastic shape, which can be anything from a thick



CALENDERING: Plastic is squeezed flat between rollers

rod or large pipe to a thin sheet or thread-like monofilament, depending upon the size and shape of the die, is forced out, it is usually conveyed through a water bath that sets the shape.

Plastics can also be extruded as coatings around continuous lengths of wire or cable.

While these three techniques—injection, compression, and extrusion—account for the production of the major share of plastics products, other variations in molding techniques are possible. In blow molding, for example, which is used in the production of plastics bottles, thermoplastics sheets or charges from an extrusion machine are placed in closed molds and are forced into final form by being blown into these molds with air or steam pressure. Pulp molding and jet molding are other techniques used for specialized applications.

Casting

Although these molding methods differ in many respects from each other, they all have one thing in common—the use of heat and external pressure. Where no pressure is used, the process is known as casting. In casting, the plastic (either thermoplastic or thermosetting) is supplied in liquid form or in granular or powdered form that can be liquefied by heating or by the addition of solvents, catalysts, etc. The fluid plastic is poured into a mold and is cured into a solid at room temperature or by further heating.

Many variations in casting techniques are also possible. One method used for making flexible toys, overshoes, etc., is slush molding, in which a thermoplastic resin slurry (or "slush") is poured into a warm mold. The heat homogenizes the slurry into a viscous layer of the desired wall thickness, and the excess slurry is then poured out. The resin left in the mold is fully fused by additional heat, then chilled; in its final flexible form, it is simply stripped out of the mold.

Casting is also involved in one of the other two techniques which, in addition to extrusion, are available for the production of plastics film and sheet (film generally refers to sheeting 0.010 in. and thinner). When casting film or sheet, the liquid plastics material is cast on a moving belt or by precipitation in a chemical bath.

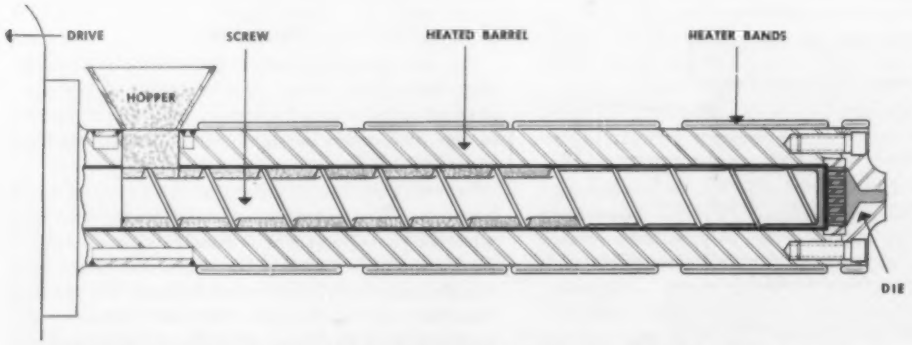
Calendering

The third major technique for turning out film and sheet is known as calendering. In calendering, the plastics compound, usually in the form of a warm doughy mass, is passed between a series of heated rollers in which it is thoroughly worked. It emerges from the rolls squeezed into flat film or sheet, the uniform thickness of which is detering, the plastics compound, usually in the form of (gaging rolls), and is cooled on a chill roll.

Calendering can also be used to apply a plastics covering to such backing materials as paper, fabric, etc. The film and backing material are simply squeezed together in the heated rollers.

Fabricating and Finishing

After plastics film, sheet, or extruded or molded shapes have been produced, additional operations are sometimes necessary before the final plastics product is ready for market. These operations generally fall under the classification of either



EXTRUSION: Softened plastic is forced by revolving screw through heated barrel and out of die

"fabricating" or "finishing," or both. Fabricating rigid plastics involves changing the size or the shape of the molded or extruded piece, adding holes or openings, etc., by such conventional metal- or wood-working techniques as drilling, tapping, turning, milling, etc. Fabricating flexible plastics film or sheeting involves cutting the material to size (film and sheeting are generally produced in continuous rolls or are available in stock sheet sizes) and turning it into an end product by sewing, heat-sealing (bonding or welding the material to itself or to other materials), etc.

The term "finishing" is generally applied to operations, e.g., tumbling, sanding, etc., for improving the surface appearance of molded plastics pieces by removing flash (excess material at the parting line) and other extraneous matter, as well as to the various decorating techniques used. When working with rigid plastics, surface decoration can take the form of stamping, printing, spraying, or vacuum metalizing (in which a metal coating is deposited on the plastic). Film, sheet, or coated materials can be metalized, printed with colorful patterns, or embossed or flocked to simulate virtually any type of surface texture.

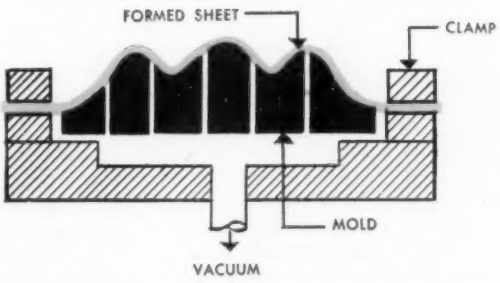
Sheet Forming

One of the most important fabricating operations —and one that has virtually grown into an entire industry of its own—is that of heat-forming film or sheeting. The basic principle is this: the heat-softened film or sheet is forced against a cold mold, permanently taking on the contours of the mold. A wide range of forming methods have been developed, differing primarily in the manner in which the sheet is heated and in the type of external pressure used to force it against the mold.

Laminates and Reinforced Plastics

Many plastics, usually liquids at room temperature, are used as binders and surfacing materials in conjunction with reinforcing materials such as fibrous glass, synthetic fibers, paper, wood, etc. Uses for plastics in this area divide into three basic categories: surface coating materials (paints, varnishes, lacquers, and coatings for fabrics, paper, etc.); bonding materials (resins to bond sand in the manufacture of foundry cores and abrasives in the manufacture of grinding wheels, etc.); and laminating materials.

For purposes of simplification, the latter classification can be further broken down into two main product groups—high-pressure laminates and low-pressure laminates. As the names imply, the difference is in the amount of pressure used in processing, but the gap is closing and higher and higher pressures are being used to produce better and better "low-pressure" laminates. The latter are commonly referred to as "reinforced plastics," although the designation could be applied to any resin reinforced with any fibers.



SHEET FORMING: Vacuum pulls heated sheet onto mold

In making a high-pressure laminate, sheets of the reinforcing material are impregnated with the liquid plastic resin and subjected to heat and high pressures while they cure into a single piece of uniform thickness. High-pressure laminates are sub-divided into decorative laminates, such as are used for counters and tabletops, and industrial laminates, which are machined into such industrial components as gears and bearings.

In molding reinforced plastics, woven cloths or nonwoven mats of the reinforcing material (glass, synthetic fibers, asbestos, etc.) are also impregnated with resin, but the laminate can be cured with little or no pressure. Molding a reinforced plastic product can be as simple as placing pre-cut pieces of reinforcing materials in an open mold, impregnating them with liquid plastic, and curing at room temperature and atmospheric pressure. However, the use of closed "matched metal" molds in heavy compression presses is becoming standard practice for the mass-production of reinforced plastics parts. It is faster and gives denser products with more closely controlled dimensions.

Combinations of Materials

To obtain the individual advantages of different plastics materials in a single product, techniques have been developed for combining materials. Laminating, for example, using heat and pressure, can be used for uniting different types of plastics film and sheeting.

"Sandwiches" are another combination material for which many uses are predicted. A sandwich construction is a multi-layered laminate formed by bonding (generally with synthetic resin adhesives) two thin, strong facings (plastics, metal, wood, etc.) to a thick, lightweight core (foamed plastics, balsa wood, honeycombs, etc.) that separates and stabilizes the thin facings, thus giving them much greater stiffness.

• • • • •

This *Primer of Plastics* touches only on the highlights of the industry. For complete discussions of specific phases, consult the Subject Index, p. 30; for definitions of words and phrases, see the Plastics Glossary that starts on the next page.

PLASTICS GLOSSARY

A

A-STAGE—An early stage in the reaction of a thermosetting resin in which the material is still soluble in certain liquids and fusible. See also *B-* and *C-Stage*.

ABSOLUTE VISCOSITY—Of a fluid, the tangential force on unit area of either of two parallel planes at unit distance apart when the space between the planes is filled with the fluid in question and one of the planes moves with unit differential velocity in its own plane.

The C.G.S. unit for absolute (or dynamic) viscosity is the poise (dyne-sec./sq. cm.). The centipoise (0.01 poise) is often used.

ACCELERATOR—A substance that hastens a reaction, particularly one which speeds up the vulcanization of rubber. Also known as *Promoter*.

ACRYLIC ESTER—An ester of acrylic acid, or of a structural derivative of acrylic acid, e.g., methyl methacrylate.

ACRYLIC RESIN—A synthetic resin prepared from acrylic acid or from a derivative of acrylic acid.

ACRYLONITRILE—A monomer with the structure (CH_2:CHCN). It is most useful in copolymers. Its copolymer with butadiene is nitrile rubber, and several copolymers with styrene exist that are tougher than polystyrene. It is also used as a synthetic fiber and as a chemical intermediate.

ADAPTOR PLATE—In injection molding, the plate holding mold which fits press or platen.

ADDITION POLYMERIZATION—See *Polymerization*.

ADHESION—The state in which two surfaces are held together by interfacial forces which may consist of valence forces or interlocking action or both.

ADHESIVE—A substance capable of holding materials together by surface attachment. Adhesive is the general term and includes, among others, the synthetic resin adhesives as well as the vegetable and animal base adhesives, such as cements, glues, mucilages, and pastes. These terms are sometimes used loosely and interchangeably.

ADSORPTION—The adhesion of the molecules of gases, dissolved substances, or liquids in more or less concentrated form to the surfaces of solids or liquids with which they are in contact.

AGING—The change in properties of a material with time under stated conditions.

ALIPHATIC HYDROCARBONS—Hydrocarbons having an open chain structure. Familiar examples include gasoline and propane.

ALKYD—Type of synthetic resin prepared from interaction of acids and alcohols. See *Polyester*.

ALLOY—Composite material made up by blending polymers or copolymers with other polymers or elastomers under selected conditions, e.g., styrene-acrylonitrile copolymer resins blended with butadiene-acrylonitrile rubbers.

ALLYL RESIN—A synthetic resin formed by the polymerization of chemical compounds containing the group $CH_2{=}CH-CH_2-$.

ALPHA-CELLULOSE—A very pure cellulose prepared by special chemical treatment.

AMINO—Indicates the presence of an $-NH_2$ or $-NH$ group.

ANGLE PRESS—Type of press used for compression and transfer molding having both a vertical and a horizontal ram, the latter being used for clamping. Developed for molding pieces having inside threads and undercuts.

ANNEALING—A process of holding a material at a temperature near, but below, its melting point, the objective being to permit stress relaxation without distortion of shape. It is often used on molded articles to relieve stresses set up by flow into the mold.

ANTIOXIDANT—Substance which prevents or slows down oxidation of material exposed to air.

ARC RESISTANCE—Time required for a given electrical current to render the surface of a material conductive because of carbonization by the arc flame.

AROMATIC HYDROCARBONS—Hydrocarbons derived from or characterized by the presence of unsaturated ring structures.

ASPHALT—A dark-colored viscous to solid hydrocarbon complex including: *a*) the easily fusible bitumens often associated with a mineral matrix, not having a waxy luster or unctuous feel; *b*) fusible residuums obtained from the distillation, etc., of bitumens.

ATOMIC WEIGHT—Relative weight of an atom of any element as compared with that of one atom of oxygen taken as 16.

AUTOCLAVE—1) Closed strong vessel for conducting chemical reactions under high pressure; 2) in low-pressure laminating, a round or cylindrical container in which heat and fluid pressure can be applied to resin-impregnated paper or fabric positioned in layers over a mold.

AUTOMATIC MOLD—Specially designed mold adaptable to a completely automatic molding machine.

B

B-STAGE—An intermediate stage in the reaction of a thermosetting resin in which the material softens when heated and swells in contact with certain liquids but does not entirely fuse or dissolve. Resins in thermosetting molding compounds are usually in this stage. See also *A-Stage* and *C-Stage*.

BACKING PLATE—In injection molding, a plate used as a support for the cavity blocks, guide pins, bushings, etc.

BAG MOLDING—A method of applying pressure during bonding or molding, in which a flexible cover, usually in connection with a rigid die or mold, exerts pressure on the material being molded, through the application of air pressure or drawing of a vacuum.

BENZENE RING—Graphic representation of the benzene nucleus, a ring of six carbon atoms believed

to exist in the aromatic compounds. In benzene, 6 hydrogen atoms are joined to the ring.

BETA GAGE—Electronic device that continuously measures the thickness of sheet products without contacting the material being gaged.

BLANKING—The cutting of flat sheet stock to shape by striking it sharply with a punch while it is supported on a mating die. Punch presses are used. Also called *Die Cutting*.

BLEED—To give up color when in contact with water or a solvent; undesired movement of certain materials in a plastic (e.g., plasticizers in vinyl) to the surface of the finished article or into an adjacent material. Also called *Migration*.

BLISTER—A raised area on the surface of a molding caused by the pressure of gases inside it on its incompletely hardened surface.

BLOCKING—An undesired adhesion between touching layers of a material, such as occurs under moderate pressure during storage or use.

BLOOM—See *Lubricant Bloom*.

BLOW MOLDING—Method of producing hollow plastic objects by stretching and hardening softened plastic material against a mold through the application of pressure, usually by compressed air.

BLOWING AGENTS—See *Foaming Agents*.

BODY (n.)—A qualitative indication of the viscosity of oil, varnish, or paint; "heavy body" denotes a relatively high viscosity and "light body" a relatively low viscosity. (v.)—To increase the viscosity of an oil by heat treatment or by other means.

BOSS—Protuberance on a plastic part designed to add strength, to facilitate alignment during assembly, to provide for fastenings, etc.

BRANCHED—In molecular structure of polymers (as opposed to *Linear*), refers to side chains attached to the main chain. Side chains may be long or short.

BREAKER PLATE—A perforated plate located to the rear of the die in an extruder. It supports the screens that prevent foreign particles from entering the die. Also *Screen Plate*.

BREATHING—The opening and closing of a mold to allow gases to escape early in the molding cycle. Also called *degassing*. When referring to plastic sheeting, "breathing" indicates permeability to air.

BULK DENSITY—The mass per unit volume of a molding powder as determined in a reasonably large volume. The recommended test method is ASTM D1182-54.

BULK FACTOR—The ratio of the volume of loose molding powder to the volume of the finished molded article.

C

C-STAGE—The final stage in the reactions of a thermosetting resin in which the material is relatively insoluble and infusible. Thermosetting resins in a fully cured plastic are in this stage. See *A-Stage* and *B-Stage*.

CALENDER (*v.*)—To prepare sheets of material by pressure between two or more revolving rolls. (*n.*)—The machine performing this operation.

CAPROLACTAM—A cyclic amide-type compound, containing 6 carbon atoms. When the ring is opened, caprolactam is polymerizable into a nylon resin known as type-6 nylon or polycaprolactam.

CASEIN—A protein material precipitated from skimmed milk by the action of either rennet or dilute acid.

Rennet casein finds its main application in the manufacture of plastics. Acid casein is a raw material used in a number of industries including the manufacture of adhesives.

CAST—To form a plastic material into a certain shape by pouring it into a mold and letting it harden without applying external pressure. Also applies to forming plastic film and sheet by pouring the liquid resin onto a moving belt or by precipitation in a chemical bath.

CASTING—The finished product of a casting operation; should not be used for *molding*, q.v.

CATALYST—A substance which markedly speeds up the cure of a compound when added in minor quantity as compared to the amounts of primary reactants. See also *Hardener* and *Inhibitor*.

CAVITY—Depression in a mold made by casting, machining, hobbing, or a combination of these methods; depending on number of such depressions, molds are designated as *Single-Cavity or Multi-Cavity*.

CELLULAR PLASTICS — See *Foamed Plastics*.

CELLULOID—A thermoplastic material made by the intimate blending of cellulose nitrate q.v., with camphor. Alcohol is normally employed as a volatile solvent to assist plasticization, and is subsequently removed.

CELLULOSE — Inert substance, chemically a carbohydrate, which makes up the solid structure of plants.

CELLULOSE ACETATE—An acetic acid ester of cellulose. It is obtained by the action, under rigidly controlled conditions, of acetic acid and acetic anhydride on purified cellulose usually obtained from cotton linters. All three available hydroxyl groups in each glucose unit of the cellulose can be acetylated but in the material normally used for plastics it is usual to acetylate fully and then to lower the acetyl value (expressed as acetic acid) to 52-56% by partial hydrolysis. When compounded with suitable plasticizers it gives a tough thermoplastic material.

CELLULOSE ACETATE BUTYRATE—An ester of cellulose made by the action of a mixture of acetic and butyric acids and their anhydrides on purified cellulose.

It is used in the manufacture of plastics which are similar in general properties to cellulose acetate but are tougher and have better moisture resistance and dimensional stability.

CELLULOSE ESTER—A derivative of cellulose in which the free hydroxyl groups attached to the cellulose chain have been replaced wholly or in part by acidic groups, e.g., nitrate, acetate, or stearate groups. Esterification is effected by the use of a mixture of an acid with its anhydride in the presence of a catalyst, such as sulfuric acid. Mixed esters of cellulose, e.g., cellulose acetate butyrate, are prepared by the use of mixed acids and mixed anhydrides. Esters and mixed esters, a wide range of which is known, differ in their compatibility with plasticizers, in molding properties, and in physical characteristics.

These esters and mixed esters are used in the manufacture of thermoplastic molding compositions.

CELLULOSE NITRATE (Nitrocellu-

lose)—A nitric acid ester of cellulose manufactured by the action of a mixture of sulfuric acid and nitric acid on cellulose, such as purified cotton linters. The type of cellulose nitrate used for celluloid manufacture usually contains 10.8-11.1% of nitrogen. The latter figure is the nitrogen content of the dinitrate.

CELLULOSE PROPIONATE—An ester of cellulose made by the action of propionic acid and its anhydride on purified cellulose. It is used as the basis of a thermoplastic molding material.

CENTRIFUGE—A rotating device for separating solids from liquids or liquids of markedly different specific gravities.

CHAIN LENGTH—See *Degree Of Polymerization.*

CHARGE—The measurement or weight of material used to load a mold at one time or during one cycle.

CHASE—An enclosure of any shape, used to: a) shrink-fit parts of a mold cavity in place; b) prevent spreading or distortion in hobbing; c) enclose an assembly of two or more parts of a split cavity block.

CHLOROPRENE—A 2-chloro-1, 3-butadiene—a colorless liquid which will polymerize to polychloroprene (neoprene).

CHROME-PLATED MOLDS—Hard chromium plating is applied to molds to provide corrosion and abrasion resistance and a low coefficient of friction.

CLAMPING PLATE—A plate fitted to a mold and used to fasten the mold to a molding machine.

CLAMPING PRESSURE—In injection molding and in transfer molding, the pressure which is applied to the mold to keep it closed, in opposition to the fluid pressure of the compressed molding material.

COEFFICIENT OF EXPANSION—Ratio of increase in length, area, or volume of a substance for a unit temperature rise.

COLD FLOW—See *Creep.*

COLD MOLDING—A procedure in which a composition is shaped at room temperature and cured by subsequent baking.

COLD PRESSING—A bonding operation in which an assembly is subjected to pressure without the application of heat.

COLD SLUG—The first material to enter an injection mold; so called because in passing through sprue orifice it is cooled below the effective molding temperature.

COLD SLUG WELL—Space provided directly opposite the sprue opening in an injection mold to trap the cold slug.

COLD STRETCH—Pulling operation, usually on extruded filaments, to improve tensile properties.

COLLOID—Any substance in a state of fine dispersion, with particles having size range between 5 and 100 millimicrons. Molecules of many synthetic resins fall within this range.

COMPRESSION MOLD—A mold which is open when the material is introduced and which shapes the material by heat and by the pressure of closing.

COMPRESSION MOLDING—A technique of thermoset molding in which the molding compound (generally preheated) is placed in the open mold cavity, mold is closed, and heat and pressure (in the form of a downward moving ram) are applied until the material has cured.

COMPRESSIVE STRENGTH—Crushing load at the failure of a specimen divided by the original sectional area of the specimen.

CONDENSATION—A chemical reaction in which two or more molecules combine with the separation of water or some other simple substance. If a polymer is formed, the condensation process is called *Polycondensation.* See also *Polymerization.*

CONDENSATION RESIN—A resin formed by polycondensation, e.g., the alkyd, phenol-aldehyde, and urea formaldehyde resins.

CONTACT PRESSURE RESINS—Liquid resins which thicken or resinify on heating and, when used for bonding laminates, require little or no pressure.

COOLING FIXTURE—Block of metal or wood holding the shape of a molded piece which is used to maintain the proper shape or dimensional accuracy of a molding after it is removed from the mold until it is cool enough to retain its shape without further appreciable distortion. Also known as *Shrink Fixture.*

COPOLYMER—See *Polymer.*

CORE—The central member of a sandwich construction (can be honeycomb material, foamed plastic, or solid sheet) to which the faces of the sandwich are attached; the central member of a plywood assembly.

CORE PIN—A pin for forming a hole or opening in a molded piece.

COVER MOLD—The stationary half of an injection mold; also called *Front Mold.*

CRAZING—Fine cracks which may extend in a network on or under the surface or through a layer of a plastic material.

CREEP—The dimensional change with time of a material under load, following the initial instantaneous elastic deformation. Creep at room temperature is sometimes called *Cold Flow.*

CROSS LAMINATED—Laminated so that some of the layers of material are oriented at right angles to the remaining layers with respect to the grain or strongest direction in tension. Normally balanced construction of the laminations about the center line of the thickness of the laminate is assumed. See *Parallel Laminated.*

CROSS-LINK—Tying together large molecules (and, hence, changing the physical properties of a material), accomplished by radiation or other means.

CULL—Material remaining in a transfer chamber after mold has been filled. Unless there is a slight excess in the charge, the operator cannot be sure cavity is filled. Charge is generally regulated to control thickness of cull.

CURE—To change the physical properties of a material by chemical reaction, which may be condensation, polymerization, or vulcanization; usually accomplished by the action of heat and catalysts, alone or in combination, with or without pressure.

CURING TEMPERATURE—Temperature at which a cast, molded, or extruded product, a resin-impregnated reinforcing material, an adhesive, etc., is subjected to curing.

CURING TIME (Molding Time)—In the molding of thermosetting plastics. The interval of time between the instant of cessation of relative movement between the moving parts of a mold and the instant that pressure is released.

CUT-OFF—The line where the two halves of a mold come together; also called a *Land* or *Flash Ridge, Flash Groove.*

CYCLE—One complete operation of

a molding press from closing time to closing time.

D

DAYLIGHT OPENING—Clearance between two platens of a press in the open position.

DECORATIVE SHEET—A laminated plastics sheet used for decorative purposes in which the color and/or surface pattern is an integral part of the sheet.

Standards of quality for certain types of synthetic resin-bonded-paper sheet for decorative purposes are given in B.S. 1323 "Synthetic resin-bonded-paper sheet (thermosetting) for use in the building industry."

DEGASSING—See *Breathing*

DEGREE OF POLYMERIZATION (DP)—The number of structural units or mers in the "average" polymer molecule in a particular sample. In most plastics the DP must reach several thousand if worthwhile physical properties are to be had.

DELAMINATE—To split a laminated plastic material along the plane of its layers; see *Laminate*.

DELAMINATION—The separation of layers in a laminate because of failure of the adhesive.

DENIER—A unit of yarn number. The number of grams per 9000 meters length.

DENSITY—Weight per unit volume of a substance, expressed in grams per cubic centimeter, pounds per cubic foot, etc.

DESICCANT—Substance which can be used for drying purposes because of its affinity for water.

DESTATICIZATION—Treating plastics materials to minimize their accumulation of static electricity and, consequently, the amount of dust picked up by the plastics because of such charges.

DIELECTRIC—Insulating material. In radio-frequency preheating, dielectric may refer specifically to the material which is being heated.

DIELECTRIC CONSTANT—Normally the relative dielectric constant; for practical purposes, the ratio of the capacitance of an assembly of two electrodes separated solely by a plastics insulating material to its capacitance when the electrodes are separated by air (ASTM Dl50-54T).

DIELECTRIC HEATING (Electronic heating)—Heating produced by dielectric loss.

DIELECTRIC STRENGTH—The ability of an insulating material to resist the passage of a disruptive discharge produced by an electric stress.

DIMENSIONAL STABILITY—Ability of a plastic part to retain the precise shape in which it was molded, fabricated, or cast.

DIP COATING—Deposition of a plastic coating on any article (for purposes of protection or decoration) by means of a simple dipping operation.

DISCOLORATION — Any change from an initial color possessed by a plastic; a lack of uniformity in color where color should be uniform over the whole area of a plastic object. In the latter sense, where they can be applied, use the more definite terms *Mottle, Segregation,* or *Two-Tone*.

DISPERSION—Finely divided particles of a material in suspension in another substance.

DISSIPATION FACTOR — See *Power Factor*.

DOUBLE-SHOT MOLDING—A means of turning out two-color parts in thermoplastics materials by successive injection molding operations.

DRAFT—The degree of taper of a side wall or the angle of clearance designed to facilitate removal of parts from a mold.

DRAPE ASSIST FRAME—In sheet thermoforming, a frame (made up of anything from thin wires to thick bars) shaped to the peripheries of the depressed areas of the mold and suspended above the sheet to be formed. During forming, the assist frame drops down drawing the sheet tightly into the mold and thereby preventing webbing between high areas of the mold and permitting closer spacing in multiple molds.

DRAPE FORMING—Method of forming thermoplastic sheet in which the sheet is clamped into a movable frame, heated, and draped over high points of a male mold. Vacuum is then pulled to complete the forming operation.

DRAWING—The process of stretching a thermoplastic sheet or rod to reduce its cross-sectional area.

DRY COLORING—Method commonly used by fabricators for coloring plastics by tumble blending crystal particles of the plastic with selected dyes and pigments.

DRY STRENGTH—The strength of an adhesive joint determined immediately after drying under specified conditions or after a period of conditioning in the standard laboratory atmosphere. See *Wet Strength*.

DRYING OIL—A special type of oil, such as tung or perilla, which hardens readily when exposed to the air; used as an ingredient in varnishes.

DUPLICATING—Milling operation in which the contour or outline to be milled is followed by a tracer or stylus that governs the motion of one or more cutting spindles.

DWELL—A pause in the application of pressure to a mold, made just before the mold is completely closed, to allow the escape of gas from the molding material.

E

EJECTOR PIN—A device that knocks a finished piece out of the mold.

EJECTOR PIN ASSEMBLY—All the parts that help to knock the finished piece from a mold. In some designs, it also frees split parts or loose pieces from mold cavities.

EJECTOR PIN PLATE—A plate which supports ejector pins and holds ejector assembly together.

EJECTOR RETURN PINS—Projections that push the ejector assembly back as the mold closes; also called *Surface Pins* and *Return Pins*.

EJECTOR ROD—Bar that actuates the ejector assembly when mold is opened.

ELASTOMER—A material which at room temperature can be stretched repeatedly to at least twice its original length and, upon immediate release of the stress, will return with force to its approximate original length.

ELECTRIC STRENGTH (Dielectric Strength)—1) That property of an insulating material which enables it to withstand electric stress. 2) The highest electric stress which an insulating material can withstand for a specified time without the occurrence of electrical breakdown by any path through its bulk. Its value is given by the potential difference in volts

divided by the thickness of a test specimen in thousandths of an inch, i.e. in volts per mil (ASTM D149-55T). 3) The highest potential difference which a specimen of insulating material of given thickness can withstand for a specified time without the occurrence of electrical breakdown by any path through its bulk.

ELECTROFORMED MOLDS—A mold made by electroplating metal on the reverse pattern on the cavity. Molten steel may be then sprayed on the back of the mold to increase its strength.

ELONGATION—The increase in length of a material when it is subjected to tensile stress. It is expressed as a fraction of the original length.

EMULSION—A suspension of fine droplets of one liquid in another.

ENCAPSULATING—Enclosing an article (usually an electronic component or the like) in a closed envelope of plastic, by immersing the object in a casting resin and allowing the resin to polymerize or, if hot, to cool.

EPOXY RESINS—Based on ethylene oxide, its derivatives or homologs, epoxy resins form straight-chain thermoplastics and thermosetting resins, e.g., by the condensation of bisphenol and epichlorohydrin.

ESTER—The reaction product of an alcohol and an acid.

EXOTHERM—1) The temperature/time curve of a chemical reaction giving off heat, particularly the polymerization of casting resins. 2) The amount of heat given off. The term has not been standardized with respect to sample size, ambient temperature, degree of mixing, etc.

EXOTHERMIC—An adjective describing chemical reactions that give off heat to the surroundings. If this heat is not removed, the temperature of the reacting mass keeps rising until the reaction is complete.

EXPANDED PLASTICS — See *Foamed Plastics*

EXTENDER—A substance, generally having some adhesive action, added to a plastic composition to reduce the amount of the primary resin required per unit area.

EXTRUDATE—The product or material delivered by an extruder, such as film, pipe, the coating on wire, etc.

EXTRUSION—The compacting of a plastic material and the forcing of it through an orifice in more or less continuous fashion.

F

FABRICATE—To work a material into a finished form by machining, forming, or other operation or to make flexible film or sheeting into end-products by sewing, cutting, sealing, or other operation.

FILAMENT—A variety of fiber characterized by extreme length, which permits its use in yarn with little or no twist and usually without the spinning operation required for fibers.

FILLER—A cheap, inert substance added to a plastic to make it less costly. Fillers may also improve physical properties, particularly hardness, stiffness, and impact strength. The particles are usually small, in contrast to those of reinforcements (q.v.), but there is some overlap between the functions of the two.

FILLER-SPECKS—Visible specks of woodflour, asbestos, or other filler, which stand out in contrasting color against a plastic binder.

FILLET—A rounded filling of the internal angle between two surfaces of a plastic molding.

FILM—An optional term for sheeting having a nominal thickness not greater than 0.010 inch.

FIN—The web of material remaining in holes or openings in a molded part which must be removed in finishing.

FINES—Pulverized particles of materials accompanying larger grains or fibers.

FLAME SPRAYING—Method of applying a plastic coating in which finely powered fragments of the plastic, together with suitable fluxes, are projected through a cone of flame onto a surface.

FLAKE—Used to denote the dry, unplasticized base of cellulosic plastics.

FLAMMABILITY—Measure of the extent to which a material will support combustion.

FLASH — Excess plastic material which forms at the parting line during molding, and which must be removed from the finished article.

FLASH LINE—A raised line appearing on the surface of a molding and formed at the junction of mold faces.

FLASH MOLD—A mold designed to permit excess molding material to escape during closing.

FLEXIBLE MOLDS—Molds made of rubber or elastomeric plastics used for casting plastics. They can be stretched to remove cured pieces with undercuts.

FLEXIBLE RESIN—A resin that is, in comparison with others under consideration, less stiff. Loosely, any material in which the modulus of elasticity is so low that it is of no practical importance.

FLEXIBILIZER—An additive that makes a resin or rubber more flexible, i.e., less stiff. Also a plasticizer.

FLEXURAL STRENGTH—Ability of a material to withstand failure due to bending.

FLOATING PLATEN—A platen located between the main head and the press table in a multi-daylight press and capable of being moved independently of them.

FLOW—A qualitative description of the fluidity of a plastic material during the process of molding.

FLOW LINE (Weld Line)—A line on the surface of a molding corresponding to an area of discontinuity within the molding due to partial hardening of material before flow has finally ceased.

FLOW MARK—A mark on a molding caused by the flow of partially hardened molding material along the surface of the mold.

FOAMED PLASTICS—Resinous materials that have been expanded into a multicellular structure characterized by low density and relatively high strength. Used as a core material in sandwich structures, as an insulating material, as cushioning, etc.

FOAMING AGENTS—Chemical additives for plastics and rubber that decompose on heating, yielding gases which produce lightweight cellular products, e.g., foamed plastics.

FORCE PLATE—The plate that carries the plunger or force plug of a mold and guide pins or bushings. Since it is usually drilled for steam or water lines, it is also called the *Steam Plate*.

FORCE PLUG—The portion of a mold that enters the cavity block and exerts pressure on the mold-

ing compound, designated as *Top Force* or *Bottom Force* by position in the assembly; also called *Plunger* or *Piston*.

FULLY AUTOMATIC PRESS—A hydraulic press for compression molding, or an injection molding machine, which operates continuously, the timing of the operations being controlled mechanically, electrically, hydraulically, or by a combination of these methods.

FURAN RESINS—Dark colored, thermosetting resins available primarily as liquids ranging from low-viscosity polymers to thick, heavy sirups.

FUSION—The operation of liquefying or combining materials by means of heat.

G

GATE—The short, restricted section of the runner at entrance to an injection mold cavity.

GEL (*n.*)—A semi-solid system consisting of a network of solid aggregates in which liquid is held.

GELATION—Process of turning a flowable liquid into a nonflowing jelly. This may be accomplished by addition or precipitation of a solforming agent, by chilling, or by evaporating solvent.

GEL COAT—A thin, outer layer of resin, sometimes containing pigment, applied to a reinforced plastics molding as a cosmetic.

GRANULAR STRUCTURE—Nonuniform appearance of finished plastic material due to retention of, or incomplete fusion of, particles of composition, either within the mass or on the surface.

GRIDS—Parallel channel-shaped cast iron supports that hold the steam plates away from the press platens during knockout operation and also provide air spaces between plates and platens to reduce loss of heat.

GUIDE PINS—Devices that maintain proper alignment of force plug and cavity as mold closes.

GUM (*n.*)—Any of a class of colloidal substances, exuded by or prepared from plants, sticky when moist, composed of complex carbohydrates and organic acids, which are soluble or swell in water. The term *Gum* is sometimes used loosely to denote various materials that exhibit gummy characteristics under certain conditions, i.e., gum balata, gum benzoin, and gum asphaltum. Gums are included by some in the category of natural resins.

H

HAND—The texture or feel of a fabric.

HARDENER—A substance or mixture of substances added to plastic composition, or an adhesive to promote or control the curing reaction by taking part in it. The term is also used to designate a substance added to control the degree of hardness of the cured film. See also *Catalyst*.

HEAT DISTORTION POINT—The temperature at which a standard bar of plastic material will be deflected 0.010 inch.

HEAT MARK—An extremely shallow, regular, or irregular depression or groove in the surface of a plastic visible only because of a sharply defined rim or a roughened surface.

HEAT-SEAL—To bond or weld a material (usually flexible film or sheeting) to itself or to another material by heat alone. Heating methods usually employed are dielectric, electronic, or inductive.

HEATING CHAMBER—In injection and transfer molding, that part of the machine in which the cold feed is reduced to a hot melt.

HEATING CYLINDER (Heating chamber, Feed cylinder)—The chamber of an injection molding machine wherein materials are plasticated by heat before being injected into the mold. This chamber may be constructed of stainless steel and may be heated by electrical or other means.

H. F. PREHEATING—A process in which a rapidly alternating electric field (20 to 80 mc.) is applied to a plastic, usually a thermoset, in order to bring it up to the molding temperature. Heating depends on dielectric loss in the resin and is fast and uniform.

HIGH-PRESSURE LAMINATES—Laminates molded and cured at pressures not lower than 1000 p.s.i. and more commonly in the range of 1200 to 2000 p.s.i.

HOB—A master model in hardened steel used to sink the shape of a mold into a soft steel block.

HOBBING—A process of forming a mold cavity by forcing a hardened steel master model of the shape desired into a soft steel cavity blank which is then trimmed to size, hardened, and polished.

HONEYCOMB—Manufactured product consisting of sheet metal or a resin-impregnated sheet material (paper, fibrous glass, etc.) which has been formed into hexagonal-shaped cells. Used as core material for sandwich constructions.

HOPPER—Receptacle located at the top of a molding machine into which plastic material is placed and from which it is metered into the heating chamber of the machine.

HOPPER DRYER—A combination feeding and drying device for extrusion and injection molding of thermoplastics. Hot air flows upward through the hopper containing the feed pellets.

HOT-MELT COATING—Applying a thermoplastic coating when it is heated and consequently in a fluid state. (Also *Dip Coating*.)

HOT-RUNNER MOLDS—A mold in which material in the runners of the mold are always in a plasticated condition.

HOT-STAMPING—Engraving operation for marking plastics in which roll leaf is stamped with heated metal dies onto the face of the plastics. Ink compounds can also be used. By means of felt rolls, ink is applied to type and by means of heat and pressure, type is impressed into the material, leaving the marking compound in the indentation.

HUB—Word frequently used for *Hob*. See *Hobbing*.

HYDROGENATION — Chemical process whereby hydrogen is introduced into a compound.

HYDROLYSIS—Chemical decomposition of a substance involving the addition of water.

HYDROLYZE.—To undergo *Hydrolysis*.

HYDROPHILIC—Possessing strong affinity for water.

HYDROPHOBIC—Lacking strong affinity for water.

HYGROSCOPIC—Tending to absorb moisture.

I

IMPACT RESISTANCE—Relative susceptibility of plastics to fracture by shock, e.g., as indicated by

the energy expended by a standard pendulum type impact machine in breaking a standard specimen in one blow.

IMPACT STRENGTH—1) The ability of a material to withstand shock loading. 2) The work done in fracturing, under shock loading, a specified test specimen in a specified manner.

INDEX OF REFRACTION—The ratio of the velocity of light in a vacuum to its velocity in the substance; the ratio of the sine of the angle of incidence to the sine of the angle of refraction.

INFRA-RED—Zone of invisible radiations below the red end of the spectrum of visible radiations. Waves are longer and more penetrating than those of light; zone is characterized by heat.

INHIBITOR—A substance that slows down chemical reaction. Inhibitors are sometimes used in certain types of monomers and resins to prolong storage life.

INJECTION MOLD—A mold into which a plasticated material is introduced from an exterior heating cylinder.

INJECTION MOLDING—A molding procedure whereby a heat-softened plastic material is forced from a cylinder into a relatively cool cavity which gives the article the desired shape.

INJECTION PRESSURE—The pressure on the face of the injection ram at which molding material is injected into a mold. It is usually expressed in p.s.i.

INJECTION RAM—The ram which applies pressure to the plunger in the process of injection molding or transfer molding.

INSERT—An integral part of a plastics molding consisting of metal or other material which may be molded into position or may be pressed into the molding after the molding is completed.

INTERCONNECTING—Applies to open-cell foamed plastics materials.

INTRINSIC VISCOSITY—The intrinsic viscosity of a polymer is the limiting value at infinite dilution of the ratio of the specific viscosity of the polymer solution to its concentration in moles per liter.

$$\eta_i = \underset{c \to 0}{\text{Lim}} \frac{\eta_{sp}}{c}$$

where η_i = intrinsic viscosity, η_{sp} = specific viscosity, c = concentration in moles per liter. Intrinsic viscosity is usually estimated by determining the specific viscosity at several low concentrations and extrapolating the values of $\frac{\eta_{sp}}{c}$ to c = 0. The concentration is expressed in terms of the repeating unit. In the case of polystyrene the repeating unit is $-CH_2-CH(C_6H_5)-$ and has a molecular weight of 104.

ION EXCHANGE RESINS—Small granular or bead-like particles containing acidic or basic groups, which will trade ions with salts in solutions. Generally used for softening and purifying water.

IRRADIATION (ATOMIC)—As applied to plastics, refers to bombardment with a variety of subatomic particles, generally alpha-, beta-, or gamma-rays. Atomic irradiation has been used to initiate polymerization and copolymerization of plastics and in some cases to bring about changes in the physical properties of a plastic material.

J

JACKET—An enveloping hollow metal cover for holding circulating steam or water used to heat or cool the mechanism it covers (such as a mixing vessel, mold, or platen).

JET MOLDING—Processing technique characterized by the fact that most of the heat is applied to the material as it passes through the nozzle or jet, rather than in a heating cylinder as is done in conventional processes.

JIG—Tool for holding component parts of an assembly during the manufacturing process, or for holding other tools. Also called a *Fixture*.

K

KNIT LINES—See *Weld Mark*.

KNOCKOUT PIN—A device for knocking a cured piece from a mold. Also called *Ejector Pin*.

L

LACQUER—Solution of natural or synthetic resins, etc., in readily evaporating solvents, which is used as a protective coating.

LAMINATED PLASTICS (Synthetic Resin-Bonded Laminate, Laminate)—A plastics material consisting of superimposed layers of a synthetic resin-impregnated or -coated filler which have been bonded together, usually by means of heat and pressure, to form a single piece.

LAMINATED WOOD—A bonded wood product composed of layers of wood. This generic term covers all orientations of grain of the various layers of wood. The term *Plywood* covers a form of laminated wood in which successive layers of veneer are ordinarily cross laminated, the core of which may be veneer or sawn lumber in one piece or several pieces. See *Cross Laminated*, *Parallel Laminated*, and *Plywood*.

LAMINATION—The process of preparing a laminate. Also any layer in a laminate.

LAND—The horizontal bearing surface of a semi-positive or flash mold by which excess material escapes. See *Cut-off*.

LATEX—Milky rubber-containing exudation of certain trees; aqueous dispersion of an elastomeric resin.

LAY-UP (*n.*)—As used in reinforced plastics, the reinforcing material placed in position in the mold; also the resin-impregnated reinforcement. (*v.*)—The process of placing the reinforcing material in position in the mold.

LEACH—To dissolve a substance out of another by percolation.

LIGNIN—A naturally occurring resin found in wood and other vegetation as the binding agent for the cellulosic structure.

LINEAR MOLECULE—A long chain molecule as contrasted to one having many side chains or branches.

LINTERS—Short fibers that adhere to the cotton seed after ginning. Used in rayon manufacture, as fillers for plastics, and as a base for the manufacture of cellulosic plastics.

LOADING TRAY (Charging tray)—A device in the form of a specially designed tray which is used to load the charge simultaneously into each cavity of a multi-cavity mold by the withdrawal of a sliding bottom from the tray.

LOSS FACTOR—The product of the power factor and the dielectric constant.

LOW PRESSURE LAMINATES—In

general, laminates molded and cured in the range of pressures from 400 p.s.i. down to and including pressures obtained by the mere contact of the plies.

LUBRICANT BLOOM—An irregular, cloudy, greasy film on a plastic surface.

M

MACERATE — Any chopped or shredded fabric used as a filler for a molding compound. A *molded macerate* is a variant of a molded laminate and intermediate between molded laminates and powder moldings.

MACROMOLECULE—The large ("giant") molecules which make up the high polymers.

MANDREL—The core or spindle around which paper or fabric is wound to form laminated tubes or around which resin-impregnated fibrous glass is wound to form pipe or tube.

MAT—A jackstraw arrangement of fine glass fibers uniformly distributed to form a thin, highly porous, felt-like material.

MATERIAL WELL—Space provided in a compression or transfer mold to care for bulk factor.

MATCHED METAL MOLDING—Method of molding reinforced plastics between two close-fitting metal molds mounted in a hydraulic press.

MECHANICAL ADHESION—Adhesion between surfaces in which the adhesive holds the parts together by interlocking action. See also *Specific Adhesion*.

METALIZING—Applying a thin coating of metal to a nonmetallic surface. May be done by plating or vacuum pressure.

MELAMINE FORMALDEHYDE RESIN—Classified as a synthetic resin derived from the reaction of melamine (2,4,6-triamino-1,3,5, triazine) with formaldehyde or its polymers.

MIGRATION OF PLASTICIZER—Loss of plasticizer from an elastomeric plastic compound with subsequent absorption by an adjacent medium of lower plasticizer concentration.

MODIFIED WOOD—Any wood the properties of which have been improved by chemical, thermal, and/or compression treatment.

MODULUS OF ELASTICITY—The ratio of unit stress to unit strain.

MOLD (*v.*)—To shape plastic parts or finished articles by heat and pressure. (*n.*)—1) The cavity or matrix into which the plastic composition is placed and from which it takes its form. 2) The assembly of all the parts that function collectively in the molding process.

MOLDING—Sometimes used to denote finished piece.

MOLDING CYCLE—1) The period of time occupied by the complete sequence of operations on a molding press requisite for the production of one set of moldings. 2) The operations necessary to produce a set of moldings without reference to the time taken.

MOLDING POWDER—Plastic material in varying stages of granulation, and comprising resin, filler, pigments, plasticizers, and other ingredients, ready for use in the molding operation.

MOLDING PRESSURE—The pressure applied to the ram of an injection machine or press to force the softened plastic completely to fill the mold cavities.

MOLDING SHRINKAGE (Mold Shrinkage, Shrinkage, Contraction)—The difference in dimensions, expressed in inches per inch, between a molding and the mold cavity in which it was molded, both the mold and the molding being at normal room temperature when measured.

MONOFILAMENT (Monofil)—A single filament of indefinite length. Monofilaments are generally produced by extrusion. Their outstanding uses are in the fabrication of bristles, surgical sutures, fishing leaders, tennis-racquet strings, screen materials, ropes and nets; the finer monofilaments are woven and knitted on textile machinery.

MONOMER—A relatively simple compound which can react to form a polymer. See also *Polymer*.

MULTI-CAVITY MOLD—A mold with two or more mold impressions, i.e., a mold which produces more than one molding per molding cycle.

N

NEST PLATE—A retainer plate with a depressed area for cavity blocks used in injection molding.

NONPOLAR—Having no concentrations of electrical charge on a molecular scale, thus, incapable of significant dielectric loss. Examples among resins are polystyrene and polyethylene.

NON-RIGID PLASTIC—A nonrigid plastic is one which has a stiffness or apparent modulus of elasticity of not over 50,000 p.s.i. at 25° C. when determined according to ASTM test procedure D747-43 T.

NOTCH SENSITIVITY—The extent to which the sensitivity of a material to fracture is increased by the presence of a surface inhomogeneity such as a notch, a sudden change in section, a crack, or a scratch. Low notch sensitivity is usually associated with ductile materials, and high notch sensitivity with brittle materials.

NOVOLAK—A phenolic-aldehyde resin which, unless a source of methylene groups is added, remains permanently thermoplastic. See also *Resinoid* and *Thermoplastic*.

NOZZLE—The hollow cored metal nose screwed into the extrusion end of *a*) the heating cylinder of an injection machine or *b*) a transfer chamber where this is a separate structure. A nozzle is designed to form under pressure a seal between the heating cylinder or the transfer chamber and the mold. The front end of a nozzle may be either flat or spherical in shape.

NYLON—The generic name for all synthetic fiber-forming polyamides; they can be formed into monofilaments and yarns characterized by great toughness, strength and elasticity, high melting point, and good resistance to water and chemicals. The material is widely used for bristles in industrial and domestic brushes, and for many textile applications; it is also used in injection molding gears, bearings, combs, etc.

O

OIL-SOLUBLE RESIN — Resin which at moderate temperatures will dissolve in, disperse in, or react with, drying oils to give a homogeneous film of modified characteristics.

ORANGE-PEEL—Uneven surface somewhat resembling an orange peel.

ORGANOSOL—A vinyl dispersion,

the liquid phase of which contains organic volatile liquids. See also *Plastisols.*

OVERLAY SHEET (Surfacing Mat)—A non-woven fibrous mat (either in glass, synthetic fiber, etc.) used as the top layer in a cloth or mat lay-up to provide a smoother finish or minimize the appearance of the fibrous pattern.

P

PANTOGRAPH—A duplicating machine used for engraving of plastics as well as mold components. Most pantographs are equipped with a variable reducing feature permitting the work to be smaller than the model while retaining relative dimensions.

PARALLEL LAMINATED—Laminated so that all the layers of material are oriented approximately parallel with respect to the grain or strongest direction in tension. See also *Cross Laminated.*

PARALLELS—1) Spacers placed between the steam plate and press platen to prevent the middle section of the mold from bending under pressure. 2) Pressure pads or spacers between the steam plates of a mold to control height when closed and to prevent crushing the parts of the mold when the land area is inadequate.

PARTING AGENT—A lubricant, often wax, used to coat a mold cavity to prevent the molded piece from sticking to it, and thus to facilitate its removal from the mold. Also called *Release Agent.*

PARTING LINE—Mark on a molding or casting where halves of mold met in closing.

PASTE—An adhesive composition having a characteristic plastic-type consistency, i.e., a high order of yield value, such as that of a paste prepared by heating a mixture of starch and water and subsequently cooling the hydrolized product.

PERMANENT SET—The increase in length, expressed in a percentage of the original length, by which an elastic material fails to return to original length after being stressed for a standard period of time.

PERMEABILITY—1) The passage or diffusion of a gas, vapor, liquid, or solid through a barrier without physically or chemically affecting it. 2) The rate of such passage.

pH—The measure of the acidity or alkalinity of a substance, neutrality being at pH 7. Acid solutions are under 7, alkaline solutions over 7.

PHENOLIC RESIN—1) A synthetic resin produced by the condensation of a phenol with an aldehyde.

2) A synthetic resin produced by the condensation of phenol (hydroxybenzene) with formaldehyde.

Phenolic resins form the basis of thermosetting molding materials, laminated sheet, and stoving varnishes. They are also used as impregnating agents and as components of paints, varnishes, lacquers, and adhesives.

PILL—See *Preform.*

PITCH—A dark-colored, fusible, more or less viscous to solid bituminous or resinous substance.

PLASTIC (*a.*)—Capable of being molded; made of any type of *Plastics.* (*n.*)—A plastic is any one of a large and varied group of materials which consists of, or contains as an essential ingredient, a substance of high molecular weight, and which, while solid in the finished state, at some stage in its manufacture is soft enough to be formed (cast, calendered, extruded, molded, etc.) into shape by flow—usually through the application singly or together of heat and pressure.

PLASTIC FLOW—Flow which is proportional to the pressure in excess of a certain minimum pressure (yield value) necessary to start the flow.

PLASTIC TOOLING—Tools, e.g. dies, jigs, fixtures, etc., for the of plastics, generally laminates or metal forming trades constructed casting materials.

PLASTICATE—To soften by heating or kneading. Synonyms are: plastify, flux, and, (imprecisely) plasticize (q.v.).

PLASTICITY—The property of solids by virtue of which they can be made to take and retain the form of a mold.

PLASTICIZE—To soften a material and make it plastic or moldable, either by means of a plasticizer or the application of heat.

PLASTICIZER—Chemical agent added to plastic compositions to make them softer and more flexible.

PLASTIGEL—A plastisol exhibiting gel-like flow properties.

PLASTISOLS—Mixtures of resins and plasticizers which can be molded, cast, or converted to continuous films by the application of heat. If the mixtures contain volatile thinners also, they are known as *Organosols.*

PLATENS—The mounting plates of a press to which the entire molding assembly is bolted.

PLUG-AND-RING — Method of sheet forming in which a plug, functioning as a male mold, is forced into a heated plastic sheet held in place by a clamping ring.

PLUNGER—See *Force Plug.*

PLYWOOD—A bonded wood product composed of laminated veneers, in which the grain of the layers of veneer are arranged in a nonparallel orientation; the usual arrangement is with the grain of successive plies at right angles.

POLAR—See *Nonpolar.*

POLYAMIDE—A polymer in which the structural units are linked by amide or thio-amide groupings. Many polyamides are fiber-forming.

POLYCONDENSATION—See *Condensation.*

POLYESTER—A resin composed of polymeric esters in which the recurring ester groups are an integral part of the main polymer chain. Unsaturated polyesters contain carbon double bonds which permit cross-linking and hence conversion of the resin to a substantially infusible and insoluble product.

POLYETHYLENE (Polythene)—A thermoplastic material composed of polymers of ethylene. It is normally a translucent, tough, waxy solid which is unaffected by water and by a large range of chemicals. It is a particularly good insulating material with low power factor and low dielectric constant, high resistivity, and high dielectric strength. An outstanding application is in cable manufacture. It is also applied in such uses as chemical plant, packaging, and for decorative purposes.

POLYISOBUTYLENE—The polymerization product of isobutylene. It varies in consistency from a viscous liquid to a rubber-like solid with corresponding variation in molecular weight from 1000 to 400,000.

POLYLINER—A perforated longi-

tudinally ribbed sleeve that fits inside the cylinder of an injection molding machine; used as a replacement for conventional injection cylinder torpedos.

POLYMER—A compound formed by the linking of simple molecules having functional groups which permit their combination to proceed to high molecular weights under suitable conditions. Polymers may be formed by polymerization (addition polymer) or by polycondensation (condensation polymer). When two or more monomers are involved, the reaction product is a copolymer.

POLYMERIZATION—A chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the original substance. When two or more monomers are involved, the process is called copolymerization or heteropolymerization. See also *Degree of, Condensation,* and *Polymer.*

POLYMERIZE—To unite molecules of the same kind into another compound having the elements in the same proportion but possessing much higher molecular weight and different physical properties.

POLYMETHYL METHACRYLATE—A thermoplastic material composed of polymers of methyl methacrylate. It is a transparent solid with exceptional optical properties and good resistance to water. It is obtainable in the form of sheets, granules, solutions, and emulsions. It is extensively used for aircraft domes, lighting fixtures, decorative articles, etc.; it is also used in optical instruments and surgical appliances.

POLYSTYRENE—A water-white thermoplastic produced by the polymerization of styrene (vinyl benzene). The electrical insulating properties of polystyrene are outstandingly good and the material is relatively unaffected by moisture. In particular the power loss factor is extremely low over the frequency range 10^3-10^8 c.p.s.

POLYVINYL ACETATE—A thermoplastic material composed of polymers of vinyl acetate in the form of a colorless solid. It is obtainable in the form of granules, solutions, latices, and pastes, and is used extensively in adhesives, for paper and fabric coatings, and in bases for inks and lacquers.

POLYVINYL ALCOHOL—A thermoplastic material composed of polymers of the hypothetical vinyl alcohol. Usually a colorless solid, insoluble in most organic solvents and oils, but soluble in water when the content of hydroxy groups in the polymer is sufficiently high.

The product is normally granular. It is obtained by the partial hydrolysis or by the complete hydrolysis of polyvinyl esters, usually by the complete hydrolysis of polyvinyl acetate. It is mainly used for adhesives and coatings.

POLYVINYL BUTYRAL—A thermoplastic material derived from a polyvinyl ester in which some or all of the acid groups have been replaced by hydroxyl groups and some or all of these hydroxyl groups replaced by butyral groups by reaction with butyraldehyde. It is a colorless flexible tough solid.

It is used primarily in interlayers for laminated safety glass.

POLYVINYL CHLORIDE (P.V.C.)—A thermoplastic material composed of polymers of vinyl chloride; a colorless solid with outstanding resistance to water, alcohols, and concentrated acids and alkalies. It is obtainable in the form of granules, solutions, latices, and pastes. Compounded with plasticizers it yields a flexible material superior to rubber in aging properties. It is widely used for cable and wire coverings, in chemical plants, and in the manufacture of protective garments.

POLYVINYL CHLORIDE `ACETATE—A thermoplastic material composed of copolymers of vinyl chloride and vinyl acetate; a colorless solid with good resistance to water, and concentrated acids and alkalies.

It is obtainable in the form of granules, solutions, and emulsions. Compounded with plasticizers it yields a flexible material superior to rubber in aging properties. It is widely used for cable and wire coverings, in chemical plants, and in protective garments.

POLYVINYLIDENE CHLORIDE—A thermoplastic material composed of polymers of vinylidene chloride (1,1-dichloroethylene). It is a white powder with softening temperature at 185-200° C. The material is also supplied as a copolymer with acrylonitrile or vinyl chloride, giving products which range from the soft flexible type to the rigid type. Also known as saran.

POSITIVE MOLD—A mold designed to trap all the molding material when it closes.

POSTFORMING—The forming, bending, or shaping of fully cured, C-stage thermoset laminates that have been heated to make them flexible. On cooling, the formed laminate retains the contours and shape of the mold over which it has been formed.

POT LIFE—See *Working Life.*

POTTING—Similar to *Encapsulating* (q.v.), except that steps are taken to insure complete penetration of all the voids in the object before the resin polymerizes.

POWER FACTOR—In an insulating material, the ratio of total power loss (watts) in the material to the product of voltage and current in a capacitor in which that material is a dielectric.

PRECIPITATE (*n.*) — Material which is separated out of a solution in the form of a solid. (*v.*)—Act of separating out such solid by physical or chemical means.

PREFORM (*n.*)—A compressed tablet or biscuit of plastic composition used for efficiency in handling and accuracy in weighing materials. (*v.*)—To make plastic molding powder into pellets or tablets.

PREHEATING—The heating of a compound prior to molding or casting in order to facilitate the operation or to reduce the molding cycle.

PREIMPREGNATION—In reinforced plastics molding, it is used to refer to applying the resin to the reinforcing material before shipping it to the molder who will use it.

PREMIX—In reinforced plastic molding, the material made by "do-it-yourselfers," molders, or end-users who purchase polyester resin, reinforcement, fillers, etc., separately and mix the reinforced molding compounds on their own premises.

PREPLASTICATION—Technique of premelting injection molding powders in a separate chamber, then transferring the melt to the injection cylinder. Device used for preplastication is commonly known as a preplasticizer. See *Plasticate.*

PREPLASTICIZE (Preplasticizer)—See *Preplastication*

PREPREG—A term generally used in reinforced plastics to mean the reinforcing material containing or combined with the full complement of resin before molding.

PREPRINTING—In sheet thermoforming, the distorted printing of sheets before they are formed. During forming the print assumes its proper proportions.

PRESS POLISH—A finish for sheet stock produced by contact, under heat and pressure, with a very smooth metal which gives the plastic a high sheen.

PRESSURE PADS—Reinforcements of hardened steel distributed around the dead areas in the faces of a mold to help the land absorb the final pressure of closing without collapsing.

PRESSURE-SENSITIVE ADHESIVE—An adhesive made so as to adhere to a surface at room temperature by briefly applied pressure alone.

PULL-BACK—Device to bring the press platen to the open position by the operation of hydraulic cylinders; also used to operate ejection devices. See *Push-back.*

PULP—A fibrous cellulosic mass into which wood or vegetable products may be converted by prolonged cooking to remove non-cellulosic matter.

PULP MOLDING—Process by which a resin-impregnated pulp material is preformed by application of a vacuum and subsequently oven cured or molded.

PURGING—Cleaning one color or type of material from the cylinder of an injection molding machine by forcing it out with the new color or material to be used in subsequent production. Purging materials are also available.

PUSH-BACK—A device (usually hydraulic) used to open the press and supply the force to eject the molded parts.

R

RADIO FREQUENCY—A frequency within the range used for radio communication and radio frequency heating. In radio frequency preheating the frequencies most commonly used are between 10 and 100 megacycles.

RAM—See *Force Plug.*

RAM TRAVEL—The distance the injection ram moves in filling the mold, in either injection or transfer molding.

REINFORCED MOLDING COMPOUND—Compound supplied by raw material producer in the form of ready-to-use materials; as distinguished from premix (q.v.).

REINFORCEMENT—a strong inert material bound into a plastic to improve its strength, stiffness, and impact resistance. Reinforcements are usually long fibers of glass, sisal, cotton, etc.—in woven or non-woven form. To be effective, the reinforcing material must form a strong adhesive bond with the resin.

RELATIVE HUMIDITY—Ratio of the quantity of water vapor present in the air to the quantity which would saturate it at any given temperature.

RELATIVE VISCOSITY—The relative viscosity of a polymer in solution is the ratio of the absolute viscosities of the solution (of stated concentration) and of the pure solvent at the same temperature.

$$\eta_r = \frac{\eta}{\eta_0}$$

where η_r = relative viscosity, η = absolute viscosity of polymer solution, η_0 = absolute viscosity of pure solvent.

RELEASE AGENT—See *Parting Agent.*

RESIN—Any of a class of solid or semi-solid organic products of natural or synthetic origin, generally of high molecular weight with no definite melting point. Resins are generally water-insoluble and have little or no tendency to crystallize. However, certain resins, such as some polyvinyl alcohols and polyacrylates, are readily dispersible in water, and others, such as polyamides and polyvinylidene chloride, are readily crystallized. See also *Gum.*

RESINOID—Any of the class of thermosetting synthetic resins, either in their initial temporarily fusible state or in their final infusible state. Compare with *Thermosetting.*

RESIN POCKET—An apparent accumulation of excess resin in a small, localized section visible on cut edges of molded surfaces.

RESISTIVITY—The ability of a material to resist passage of electrical current either through its bulk or on a surface. The unit of volume resistivity is the ohm-cm., of surface resistivity, the ohm.

RESTRICTED GATE—A thin gate which, with some materials, helps to prevent residual molding stresses and so lowers the tendency of the part to stick in the mold and craze afterward.

RETAINER PLATE—The plate on which demountable pieces, such as mold cavities, ejector pins, guide pins, and bushings are mounted during molding; usually drilled for steam or water.

RETARDER—See *Inhibitor.*

RIB—A reinforcing member of a fabricated or molded part.

RIGID P.V.C.—Polyvinyl chloride or a polyvinyl chloride/acetate copolymer characterized by a relatively high degree of hardness; it may be formulated with or without a small percentage of plasticizer.

RIGID RESIN—One having a modulus high enough to be of practical importance, e.g., 10,000 p.s.i. or greater.

ROOM TEMPERATURE SETTING ADHESIVES—Adhesives which set at 68 to 86° F., inclusive, the limits for room temperature that are specified in ASTM D 618.

ROSIN—A resin obtained as a residue in the distillation of crude turpentine from the sap of the pine tree (gum rosin) or from an extract of the stumps and other parts of the tree (wood rosin).

ROTATIONAL CASTING—A hollow sectional mold is charged with a measured amount of fluid plastisol and rotated. The plastisol is forced against the interior surface of the mold by centrifugal force and, as the temperature of the material rises, it forms a gelled film on that surface. Heating of the mold is continued until the gelled plastisol reaches the fusion temperature, after which it is cooled and the molding is stripped from the mold.

ROVING—Fibrous glass reinforcement made from "cake" packages. A number of continuous strands are wound on a tube to form a cylindrical package; the number of strands can be varied—usually 60 "end" rovings are made.

RUNNER—In an injection mold, the groove that connects the sprue with the gate through which the plastic composition flows.

S

SANDWICH CONSTRUCTIONS—Panels composed of a lightweight core material—honeycomb, foamed

plastic, etc., q.v.—to which two relatively thin, dense, high strength faces or skins are adhered.

SATURATED COMPOUNDS—Organic compounds which do not contain double or triple bonds and thus cannot add on elements or compounds.

SCORING—Scratching of the surface of a mold caused by interference due to mis-matching or oversized force plug.

SCRAP—Sprues, runners, rejects, and other thermoplastic waste material which can be reground to particle size and mixed with virgin material for re-use.

SEGREGATION—A close succession of parallel, relatively narrow and sharply defined, wavy lines of color on the surface of a plastic which differ in shade from surrounding areas, and create the impression that the components have separated.

SEMI-AUTOMATIC PRESS—A hydraulic press in which certain operations are automatic.

SEMI-POSITIVE MOLD—A mold which allows a small amount of excess material to escape when it it closed. See *Flash Mold, Positive Mold.*

SET (*v.*)—To convert a liquid resin or adhesive into a fixed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. See also *Cure.*

SETTING TEMPERATURE—The temperature to which a liquid resin, an adhesive, or products or assemblies involving either is subjected to set the resin or adhesive.

SETTING TIME—The period of time during which a molded or extruded product, an assembly, etc., is subjected to heat and/or pressure to set the resin or adhesive.

SHEAR STRENGTH—a) The ability of a material to withstand shear stress. b) The stress at which a material fails in shear.

SHEETER LINES—Parallel scratches or projecting ridges distributed over a considerable area of a plastic sheet.

SHELF LIFE—See *Storage Life.*

SHORT—Mark on surface of a molded article indicating incomplete filling of the mold.

SHOT—The yield from one complete molding cycle.

SHOT CAPACITY—The maximum weight of material which an injection machine can inject per cycle into a mold.

SHRINK FIXTURE—See *Cooling Fixture.*

SIDE BARS—Loose pieces used to carry one or more molding pins, and operated from outside the mold.

SIDE DRAW PINS—Projections used to core a hole in a direction other than the line of closing of a mold, and which must be withdrawn before the part is ejected from the mold.

SILICONE—One of the family of polymeric materials in which the recurring chemical group contains silicon and oxygen atoms as links in the main chain. At present these compounds are derived from silica (sand) and methyl chloride. The various forms obtainable are characterized by their resistance to heat.

Silicones are used in the following applications: *a*) Greases for lubrication. *b*) Rubber-like sheeting for gaskets, etc. *c*) Heat-stable fluids and compounds for waterproofing, insulating, etc. *d*) Thermosetting insulating varnishes and resins for both coating and laminating.

SINK-MARK—Dimple-like depression in the surface of a molded piece indicating that it has retracted from the mold; mark has well-rounded edges and shows a surface film.

SINKING A MOLD—See *Hobbing.*

SINTERING—In forming articles from fusible powders, e.g., nylon, the process of holding the pressed-powder article at a temperature just below its melting point for about ½ hour. Particles are fused (sintered) together, but the mass, as a whole, does not melt.

SIZING (*n.*)—The process of applying a material to a surface to fill pores and thus reduce the absorption of the subsequently applied adhesive or coating or to otherwise modify the surface. Also, the surface treatment applied to glass fibers used in reinforced plastics. The material used is sometimes called *Size.*

SLIP FORMING—Sheet forming technique in which some of the plastic sheet material is allowed to slip through the mechanically operated clamping rings during a stretch-forming operation.

SLIP-PLANE—Plane within transparent material visible in reflected light, due to poor welding and shrinkage on cooling.

SLURRY PREFORMING—Method of preparing reinforced plastics preforms by wet processing techniques similar to those used in the pulp molding (q.v.) industry.

SLUSH MOLDING—Method for casting thermoplastics, in which the resin in liquid form is poured into a hot mold where a viscous skin forms. The excess slush is drained off, the mold is cooled, and the molding stripped out.

SNAP-BACK FORMING—Sheet forming technique in which an extended heated plastic sheet is allowed to contract over a male form shaped to the desired contours.

SOLUTION—Homogeneous mixture of two or more components, such as a gas dissolved in a gas or liquid, or a solid in a liquid.

SOLVENT—Any substance, usually a liquid, which dissolves other substances.

SOLVENT MOLDING—Process for forming thermoplastic articles by dipping a male mold in a solution or dispersion of the resin and drawing off the solvent to leave a layer of plastic film adhering to the mold.

SPECIFIC ADHESION—Adhesion between two surfaces which are held together by valence forces of the same type as those which give rise to cohesion. See also *Mechanical Adhesion.*

SPECIFIC GRAVITY—The ratio of the weight of the molded piece as compared to the weight of an equal volume of water.

SPECIFIC VISCOSITY—The specific viscosity of a polymer is the relative viscosity of a solution of known concentration of the polymer minus one. It is usually determined for a low concentration of the polymer (0.5 g. per 100 ml. of solution or less).

$$\eta_{SP} = \frac{\eta - \eta_o}{\eta_o} = \eta_r - 1,$$

where η_{SP} = specific viscosity η_r = relative viscosity.

SPINNERET—A metal plate with holes through which a plastic material passes into a solidifying medium, to form filaments or fibers.

SPINNING—Process for producing

synthetic fibers and filaments by forcing a viscous resin solution through fine holes in a *spinneret*, q.v.

SPIN WELDING—A process of fusing two objects together by forcing them together while one of the pair is spinning, until frictional heat melts the interface. Spinning is then stopped and pressure held until they are frozen together.

SPLIT-RING MOLD—A mold in which a split cavity block is assembled in a chase to permit the forming of undercuts in a molded piece. These parts are ejected from the mold and then separated from the piece.

SPRAYED METAL MOLDS—Mold made by spraying molten metal onto a master until a shell of predetermined thickness is achieved. Shell is then removed and backed up with plaster, cement, casting resin, or other suitable material. Used primarily as a mold in sheet-forming processes.

SPREAD—The quantity of adhesive per unit joint area applied to an adherend. It is preferably expressed in pounds of liquid or solid adhesive per thousand square feet of joint area. *Single spread* refers to application of adhesive to only one adherend of a joint. *Double spread* refers to application of adhesive to both adherends.

SPREADER—A streamlined metal block placed in the path of flow of the plastics material in the heating cylinder of extruders and injection molding machines to spread it into thin layers, thus forcing it into intimate contact with the heating areas.

SPRUE—Feed opening provided in the injection or transfer mold; also the slug formed at this hole. *Spur* is a shop term for the sprue slug.

SPRUE BUSHING—A hardened steel insert in an injection mold which contains the tapered sprue hole and has a suitable seat for the nozzle of the injection cylinder. Sometimes called an *Adapter*.

SPRUE LOCK—In injection molding, a portion of the plastic composition which is held in the cold slug well by an undercut; used to pull the sprue out of the bushing as the mold is opened. The sprue lock itself is pushed out of the mold by an ejector pin. When the undercut occurs on the cavity block retainer plate, this pin is called the *Sprue Ejector Pin*.

STABILIZER—An ingredient used in the formulation of some plastics, especially elastomers, to assist in maintaining the physical and chemical properties of the compounded materials at their initial values throughout the processing and service life of the material.

STAPLE FIBERS—Fibers of spinnable length manufactured directly or by cutting continuous filaments to short lengths.

STARVED JOINT—A joint which has an insufficient amount of adhesive to produce a satisfactory bond.

STEAM PLATE—Mounting plate for molds, cored for circulation of steam.

STEROSPECIFIC—Loosely defined as "the arrangement of molecules in a specified form." More specifically, it is described as the arrangement of polymers in a predetermined geometric form rather than in random fashion.

STITCHING—The progressive welding of thermoplastic materials by successive applications of two small mechanically operated electrodes, connected to the output terminals of a radio frequency generator, using a mechanism similar to that of a normal sewing machine.

STORAGE LIFE—The period of time during which a liquid resin or packaged adhesive can be stored under specified temperature conditions and remain suitable for use. Storage life is sometimes called *Shelf Life*.

STRETCH FORMING—A plastic sheet forming technique in which the heated thermoplastic sheet is stretched over a mold subsequently cooled.

STRIPPER-PLATE—A plate that strips a molded piece from core pins or force plugs. The stripper-plate is set into operation by the opening of the mold.

SUBSTRATE—A material upon the surface of which an adhesive containing substance is spread for any purpose, such as bonding or coating. A broader term than *Adherend*.

SURFACE RESISTIVITY—The electrical resistance between opposite edges of a unit square of insulating material. It is commonly expressed in ohms. (Also covered in ASTM D257-54T.)

SUSPENSION—Dispersion of a solid in a liquid.

SWEATING—Exudation of small drops of liquid, usually a plasticizer or softener, on the surface of a plastic part.

SYNTHETIC (*n.*, *a.*)—Chemical compound made from elements or simple compounds; applied particularly to substances that duplicate other substances occurring in nature.

SYNTHETIC RESIN—A complex, substantially amorphous, organic semi-solid, or solid material (usually a mixture) built up by chemical reaction of comparatively simple compounds, approximating the natural resins in luster, fracture, comparative brittleness, insolubility in water, fusibility or plasticity, and some degree of rubber-like extensibility; but commonly deviating widely from natural resins in chemical constitution and behavior with reagents.

T

TACK—Stickiness of an adhesive, measurable as the force required to separate an adherend from it by viscous or plastic flow of the adhesive.

TACK RANGE—The period of time in which an adhesive will remain in the tacky-dry condition after application to an adherend, under specified conditions of temperature and humidity.

TAPPING—Cutting threads in the walls of a circular hole.

TAR—Dark-colored substance of variable composition, liquid or semi-liquid at room temperature, often possessing a characteristic odor, usually insoluble in water but soluble in carbon disulfide, benzol, etc., and which on distillation, oxidation, etc., forms a pitch.

TENSILE STRENGTH—The pulling force necessary to break a given specimen, divided by the cross-sectional area.

THERMAL CONDUCTIVITY—Ability of a material to conduct heat; physical constant for quantity of heat that passes through unit volume of a substance in unit of time when difference in temperature of two faces is 1°.

THERMAL EXPANSION—See *Coefficient of*.

THERMOPLASTIC (*a.*)—Capable of being repeatedly softened by heat and hardened by cooling. (*n.*)—A material that will repeatedly soften

when heated and harden when cooled.

THERMOSET—A material that will undergo or has undergone a chemical reaction by the action of heat, catalysts, ultra-violet light, etc., leading to a relatively infusible state.

THERMOSETTING RESIN—A synthetic resin which will harden and become permanently infusible and insoluble under the influence of heat.

THIXOTROPY—The property by which some compositions become solid at rest but liquefy again on agitation.

THREAD PLUG—A part of a mold that shapes an internal thread and must be unscrewed from the finished piece.

TOGGLE ACTION—A mechanism which exerts pressure developed by the application of force on a knee joint. It is used as a method of closing presses and also serves to apply pressure at the same time.

TOLERANCE—The maximum variation in accuracy in the size of a molded or fabricated piece to be satisfactory for assembly.

TORPEDO—The torpedo-shaped device fitted into the center of the heating chamber of an injection machine to assist in the transfer of heat to the material.

TRANSFER MOLDING—A method of molding thermosetting materials, in which the plastic is first softened by heat and pressure in a transfer chamber, then transferred through suitable sprues, runners, and gates into a closed mold for final curing.

TUMBLING—Finishing operation for small plastic articles by which gates, flash, and fins are removed and/or surfaces are polished by rotating them in a barrel together with wooden pegs, sawdust, and polishing compounds.

U

ULTRA-VIOLET—Zone of invisible radiations beyond the violet end of the spectrum of visible radiations. Waves are shorter than those of light and characterized by chemical action.

UNDERCUT—Any indentation in or protrusion from a molded piece beyond the direct draw line.

UNICELLULAR—With foamed plastics, each cell an isolated unit. Equals "closed-cell."

UNSATURATED COMPOUNDS—Compounds having more than one bond between two adjacent atoms and capable of adding other atoms at that point to reduce it to a single bond.

UREA FORMALDEHYDE RESIN (Urea Resin)—A synthetic resin derived from the reaction of urea (carbamide) with formaldehyde or its polymers.

V

VACUUM FORMING—Method of sheet forming in which the plastic sheet is clamped in a stationary frame, heated, and drawn down by a vacuum into a mold. In a loose sense, it is sometimes used to refer to all sheet forming techniques, including *Drape Forming* (q.v.), involving the use of vacuum and stationary molds.

VACUUM METALIZING—Depositing a metal coating on a plastic in a vacuum chamber.

VALUE—That attribute which describes the lightness of a color, e.g., a color may be classed as equivalent to some member of the series of grays ranging from black (the zero member) to white.

VENEER—A thin sheet of wood, generally within the thickness range of 0.01 to 0.0125 inch.

VENT—In a mold, a shallow channel or minute hole cut in the cavity to allow air to escape as the material enters.

VERTICAL FLASH RING—The clearance between the force plug and the vertical wall of the cavity in a positive or semi-positive mold; also the ring of excess material which escapes from the cavity into this clearance space.

VINYL RESIN—A synthetic resin formed by the polymerization of chemical compounds containing the group $CH_2 = CH-$.

VISCOSITY—Internal friction or resistance to flow of a liquid. The constant ratio of shearing stress to rate of shear.

VOLUME RESISTIVITY (Specific Insulation Resistance)—The electrical resistance between opposite faces of a 1-cm. cube of insulating material. It is measured under prescribed conditions using a direct current potential after a specified time of electrification. It is commonly expressed in ohm-centimeters. The recommended test is ASTM D257-54T.

VULCANIZATION—A chemical reaction in which the physical properties of a rubber are changed in the direction of decreased plastic flow, less surface tackiness, and increased tensile strength by reacting it with sulfur or other suitable agents.

W

WARM SETTING ADHESIVES—A term which is sometimes used as synonymous with Intermediate Temperature Setting Adhesives.

WARP—Dimensional distortion in a plastic object after molding.

WELD-MARK—Mark formed by the incomplete union of two or more streams of plastic material flowing together in a mold.

WELDING—1) Hot gas welding: A method of welding thermoplastic materials in which the material is heated by a jet of hot air or inert gas directed from a welding "torch" on to the area of contact of the surfaces which are being welded. Welding operations to which this method is applied normally require the use of a filler rod. 2) Especially in Europe, to mean heat sealing, either conductive or electronic.

WET STRENGTH—The strength of paper when saturated with water, especially used in discussions of processes whereby the strength of paper is increased by the addition, in manufacture, of plastics resins. Also, the strength of an adhesive joint determined immediately after removal from a liquid in which it has been immersed under specified conditions of time, temperature, and pressure.

WORKING LIFE—The period of time during which a liquid resin or adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains usable.

Y

YIELD VALUE—The lowest pressure at which a plastic will flow. Below this pressure the plastic behaves as an elastic solid; above, as a viscous liquid.

INDEX

A

ABIETIC ACID ESTERS
Plasticizers chart 598

ABRASION RESISTANCE
Epoxy resins 179
Neoprene rubber 161
Nylon 133, 134
Plastics tools 744
Polyethylene 179
Styrene 178
Vinyl resins 167

ACCUMULATORS 891
Manufacturers of 1018

ACETAL, POLYVINYL (*See Vinyl Polymers and Copolymers*)

ACETATE, CELLULOSE (*See Cellulose Acetate*)

ACETATE, VINYL (*See Vinyl Polymers and Copolymers*)

ACRYLIC RESINS 86
Acrylonitrile 87
Adhesives 90, 182
Adhesives chart 564
Annealing 828
Applications of 88, 178
Bonding of 820
Cast *vs.* extruded acrylic sheet 438
Casting 747
Coatings 90, 178
Esters 86
Extrusion of 709
Fibers chart 580
Film and sheeting 434, 439, 441, 742
Injection molding of 656
Ion exchange resins 89
Manufacturers of 1018
Molding temperature for ... 658
Monomers and polymers 86
Plasticizers chart 598
Polishing 828
Polymethyl methacrylate ... 441
Properties chart ..... *facing* 554
Textile treatments with 89

ACRYLONITRILE RESINS .. 87
Coatings chart 572
Extrusion of A-B-S polymer blend 730
Fibers chart 580
Rubber, use of 156, 160

ADHESIVE BONDING 818

ADHESIVES (*See also Adhesives Chart*) 180
Acrylics in 90
Bonding qualities 180
Catalysts, use of 184
Combinations of resins 182
Elastomers 182
Epoxy 109, 182
Fillers and extenders 184
Forms of 180
Isocyanate 128, 182
Manufacturers of 1018
Melamine resins in .. 95, 181, 182
Phenolic resins in 137, 181
Polyesters in 182
Resins for adhesives 180
Resorcinol formaldehyde in 139, 181
Rubber in 182
Silicone 150
Solvents 183
Types in sandwich constructions 525
Types of 180
Urea formaldehyde in 92, 181
Vinyls in 182

ADHESIVES CHART 564

AGRICULTURAL PRODUCTS (*See also Casein and Protein Plastics*)
Adhesives chart 564

ALKYD RESINS 143, 177
Applications of 144, 177
Chemistry and manufacture . 177
Coatings chart 572
Compression molding of 683
Manufacturers of 1018
Medium- and long-oil types 144, 177
Methyl methacrylate, casting 747
Modified alkyds 144
Molding compounds 685
Non-phthalic alkyds 144
Paints, use in 144, 177
Production 143
Properties chart .... *facing* 554
Properties of 177
Short-oil alkyds 143, 177
Storage of 686
Transfer molding 684

ALKYL RESINS (*See also Polyesters*)
Coatings chart 572
Low-pressure laminating resins chart 590
Manufacturers of 1018
Properties chart ..... *facing* 554

ALKYL VINYL ETHERS (*See Vinyl Polymers and Copolymers*)

ALPHA-CELLULOSE (*See Fillers*)

AMINO RESINS (*See also Aniline, Melamine, and Urea*) 91
Applications of (Chart) 93
Colorants for 368
Manufacturers of 1018
Properties chart .... *facing* 554

ANILINE RESINS
Manufacturers of 1018
Properties chart ..... *facing* 554

ANNEALING 654, 656, 828

ARC RESISTANCE
Properties chart ..... *facing* 554

ASBESTOS
Fillers 469, 470, 482
Heat resistance 486
Laminates chart 586
Laminates, use in 483
Manufacturers of 1018
Preforms 483
Properties chart ..... *facing* 554
Reinforcements 482

ASPHALT 129
Adhesives chart 564
Coatings chart 572
Manufacturers of 1018

B

BANBURY MIXER 912

BIBLIOGRAPHY
Books 615
Magazines 615

BISPHENOLIC OIL
Coatings chart 572

BITUMEN (*See Asphalt*)

BOILERS
Manufacturers of 1018

BONDING (*See Adhesives, Cementing, Heat-Sealing, Welding*)

BOOKS 615

BUFFING (*See Machining*)

BUTADIENE POLYMERS AND COPOLYMERS 159
Acrylonitrile copolymers ... 160

Adhesives chart 564
Styrene copolymers 156
BUTYL RUBBER 160
Adhesives chart 564
Coatings chart 572

BUTYRAL, POLYVINYL (*See Vinyl Polymers and Copolymers*)

C

CALENDERING 14
Calender wind-up 907
Equipment for 905
Film and sheeting 906, 907
Mixers and mills 906
Roll arrangements 906
Styrene 157

CARBEZOL, POLYVINYL (*See Vinyl Polymers and Copolymers*)

CARBON FILLERS (*See Fillers*)

CARBOXYMETHOL CELLULOSE 97
Applications of 101
Characteristics 100
Coatings chart 572
Compounding and processing 100
Manufacturers of 1018
Preparation of 97

CASEIN PLASTICS 147
Adhesives chart 564
Applications of 147
Manufacture 147
Manufacturers of 1018
Properties chart ..... *facing* 554
Properties of 147

CASHEW RESINS 129

CAST PHENOLIC RESINS
Manufacturers of 1018
Properties chart ..... *facing* 554

CASTING 14, 747
Acrylics 747
Methacrylates 747
Plastisol molds, use of 759
Potting and encapsulation of electrical components 753
Thermosets 750

CASTING RESINS (*See also specific materials*)
Epoxies 110
Manufacturers of 1018
Phenolics 137
Polyester 143

CATALYSTS
Adhesives, curing 184
Low-pressure laminating resins chart 590

CATION EXCHANGE RESINS (*See Ion Exchange Resins*)

CELLOPHANE 97
Characteristics 101
Compounding and processing 101
Film and sheeting 439
Films chart 559
Manufacturers of 1018
Preparation of 97
Uses of 101

CELLULAR PLASTICS (*See Expanded Plastics*)

CELLULOID (*See Cellulose Nitrate*)

CELLULOSE ACETATE 96
Adhesives chart 564
Applications of 98
Bonding of 820
Cellular, in sandwich constructions 344
Cellular (Strux) 343
Characteristics of 98
Coatings chart 572
Compounding and processing 97
Extrusion of 715
Fibers chart 580
Film and sheeting .. 437, 440, 741
Films chart 559
Foam 343
Injection molding 658
Low-pressure laminating resins chart 590
Manufacturers of 1018
Plasticizers chart 598
Preparation of 96
Properties chart ..... *facing* 554

CELLULOSE ACETATE BUTYRATE 96
Adhesives chart 564
Bonding of 820
Characteristics 98
Coatings chart 572
Compounding and processing 98
Extrusion of 715
Film and sheeting .. 438, 441, 742
Films chart 559
Injection molding 658
Manufacturers of 1018
Plasticizers chart 598
Preparation of 96
Properties chart ..... *facing* 554
Uses of 99

CELLULOSE NITRATE 96
Bonding of 820
Characteristics 97
Coatings 387
Coatings chart 572
Compounding and processing 97
Films chart 559
Manufacturers of 1018
Preparation of 96
Properties chart .....*facing* 554
Uses of 97

CELLULOSE PROPIONATE . 97
Applications of 99
Bonding of 820
Compounding and processing 99
Injection molding 658
Film and sheeting 438

CELLULOSICS (*See specific materials*)

CEMENTING (*See also specific materials*)
Adhesive bonding 819
Adhesives chart 564

CERAMOPLASTICS 122

CHEMICALS FOR PLASTICS
Basic raw materials 364
Colorants 367
Organic intermediates 364
Plasticizers 381
Solvents 366
Stabilizers 377

CHLORINATED PARAFFIN
Coatings chart 572

CHLORINATED RUBBER (*See Rubber, Chlorinated*)

CHLOROTRIFLUOROETHYLENE (*See Kel-F*)

CLOTH LAMINATES (*See Fabrics, Glass, Laminates, and Reinforcements*)

COAL CHEMICALS
Use in plastics 364

COATINGS (*See also Coatings Chart, Decorating, Paints*)
Acrylic resins for 90, 178
Adhesives chart 564
Alkyd resins in 177
Cellulose nitrate 387
Enamels 829
Epoxy 107, 179
Equipment for 903
Extrusion-lamination 904
Lacquers 829
Manufacturers of 1018
Melamine resins for 95
Paper with nylon 720
Phenolic resins in 137, 177
Polyethylene .. 117, 175, 179, 735
Polyvinyl chloride base 168
Resins for 175
Solvents, use in 387
Styrene 175, 178
Thermosetting resins 752
Urea formaldehyde in 94
Urethane 127
Varnishes 175, 177

Vinyl 165, 169, 177
Wire, nylon 718

COATINGS CHART 572

COLD MOLDED COMPOUNDS 102
Applications 102
Binders for 102
Characteristics 102
Inorganic 122
Manufacturers of 1018
Organic 102
Properties chart ..... *facing* 554

COLOR AND COLORING
Colorant group characteristics 368
Colorants for plastics 367
Dyes 368
Equipment for 912
Luminous pigments for plastics 373
Paint colors 829
Pigments 369
Recoloring scrap stocks 372

COMPOUNDING
Banbury mixing 912
Chopping, granulating, dicing 916
Equipment for 912
Extruders for 915
Plasticating equipment 914
Premixing 913
Weighing equipment 912

COMPOUNDS, MOLDING (*See specific materials*)

COMPRESSION MOLDING 13, 681
Alkyds 683
Application possibilities 681
Control systems 890
Melamine formaldehyde 686
Molding temperatures for alkyds 686
Molding temperatures for melamine formaldehyde .. 687
Molding temperatures for phenolics 700, 703
Molding temperatures for urea resins 691
Phenolics 698
Preforming 685
Preforms for 685, 686, 691, 694, 695, 696
Presses, manufacturers of .. 1018
Shrinkage of materials ..684, 688, 691, 696, 701, 702
Teflon 694
Temperature control ... 686, 687, 691, 700, 703, 890
Types of molds 681
Urea formaldehyde 690

COMPRESSIVE STRENGTH
Properties chart ..... *facing* 554

COMPRESSORS
Manufacturers of 1018

CONDUCTIVITY, THERMAL
Properties chart ..... *facing* 554

CONTROL EQUIPMENT 890
Extrusion 892
Injection molding 892
Manufacturers of 1018
Temperature, compression molding 686, 687, 691, 700, 703, 890
Temperature, extrusion 714, 715, 718, 719, 721, 726, 731, 893
Temperature, transfer molding 892
Transfer molding 891

CORE MATERIALS (*See Expanded Plastics*)

CORROSION
Acrylic resistance 88
Nylon resistance; marine equipment 133
Plastics tools, resistance of .. 743

COTTON
Fibers chart 580
Fillers 469, 471
Laminates chart 586

COUMARONE-INDENE RESINS 103
Adhesives chart 564
Applications 103
Characteristics 103
Coatings chart 572
Manufacturers of 1018

D

DECORATING
Colorants for plastics 367
Dip coating 832
Embossing 444
Fill-in marking 833
Film and sheeting 444, 445
Melamine moldings 688
Metalizing 834
Molded plastics 828
Paints used 829
Polystyrene 153
Roll-leaf hot-stamping 833
Roller coating 833
Screen process printing 831
Spray coating 830

DECORATING FILM AND SHEETING 444

DENSE WOOD (*See Wood, Modified*)

DESTATICIZERS 374

DIATOMACEOUS SILICA (*See Fillers*)

DIELECTRIC BREAKDOWN
Properties chart ..... *facing* 554

DIES (*See also Molds*)
Heat-sealing, electronic 892

DIES, EXTRUSION (*See Extrusion*)

DIRECTORY 10

DISSIPATION FACTOR
Properties chart ..... *facing* 5

DISTORTION, HEAT
Properties chart ..... *facing* 5

DRAWING (*See Forming*)

DRILL PRESSES 90
Manufacturers of 1018

DRILLING (*See Fabricating and Finishing, Machining, and specific materials*)

DUPLICATING MACHINES . 90
Manufatcurers of 1018

DYES (*See Color and Coloring*)

E

ELECTRICAL INSULATION
Polyethylene 116
Silicone resins 149, 151
Vinyl chloride 167

ELECTRICAL PROPERTIES
Properties chart ..... *facing* 554

ELECTRONIC HEAT-SEALING 337, 924

EMBOSSING
Processes of 444

ENAMEL (*See Coatings and Paints*)

ENCAPSULATION OF ELECTRICAL COMPONENTS . 753

ENGINEERING AND METHODS 650

ENGRAVING (*See also Decorating*)
Machine engraving 909

EPOXY RESINS 105
Adhesives 109, 182
Bonding of 822
Casting 110, 752
Coating use 179
Coatings chart 572
Coatings, surface 107
Commercial curatives for (Table) 108
Curing process 107
Foams 110, 358
Historical development 105
Laminates 110, 510
Molding compounds 111
Potting and encapsulation of electrical components 755
Properties chart ..... *facing* 554
Properties of 105
Resin synthesis 105
Tooling, use in 110, 743

Use as stabilizers 380
Uses of 111

EQUIPMENT (*See Machinery and Equipment*)

ETHOXYLENE RESINS (*See Epoxy Resins*)

ETHYL CELLULOSE 97
Adhesives chart 564
Characteristics 100
Coatings chart 572
Compounding and processing 99
Extrusion of 715
Films chart 559
Injection molding 658
Low-pressure laminating resins chart 590
Manufacturers of 1018
Molding temperature for ... 659
Plasticizers chart 598
Properties chart ..... *facing* 554
Uses of 100

ETHYLENE POLYMERS (*See Polyethylene*)

EXPANDED PLASTICS (*See also Foamed Plastics and Foaming Plastics*)
Manufacturers of 1018
Styrene 155

EXPANSION, THERMAL
Properties chart .....*facing* 554

EXTENDERS (*See Fillers*)

EXTRUSION 13, 704
Acrylics 709
Acrylonitrile-butadiene-styrene polymer blend 730
Adiabatic system 707
Cellulosics 715
Coating (polyethylene) process 735
Control equipment 892
Die design 707, 712
Dies for 721, 724, 725, 726, 730, 731, 732, 734, 901
Equipment for 712, 717, 721, 725, 726, 727, 730, 731, 732, 898
Film and sheeting 709, 901
Instrumentation 708
Kel-F 712
Machinery, manufacturers of 1018
Motor drives 900
Nylon 717
Polycaprolactam nylon 721
Polyethylene 116, 732
Polyvinyl chloride 727
Screw design 726, 715
Screw extrusion, process 704
Screw, metering type .. 705, 717, 718, 721
Screws for 727, 730, 731, 900
Styrene 152, 157
Teflon 724
Temperature control ... 714, 715, 718, 719, 721, 726, 731, 893, 900
Vacuum forming 739
Vinyls, plasticized (Table) .. 728
Vinyls, rigid 172
Vinyls, unplasticized (Table) 729
Wire coating, Kel-F 713
Wire coating, nylon 718
Wire coating, polyethylene . 735
Wire coating, Teflon 726
Wire coating, vinyls 730

F

FABRICATING AND FINISHING 14, 818
Adhesive bonding 818
Ashing and buffing 827
Broaching laminates 517
Buffing laminates 517
Chrome-plating equipment . 911
Drilling laminates 515
Drilling thermoplastics 826
Filing thermoplastics 827
Finish wheels 827
Flycutting laminates 515
Gear cutting, plastics laminates 516
Grinding rod stock 827
Grinding tubes and rods 517
Hardening equipment 911
Laminates 514
Lathe operations on laminates 516
Milling laminates 515
Planing and shaping laminates 516
Plastics tooling 743
Polishing 517, 828, 911
Punching laminates 516
Sanding and grinding laminates 517
Sanding thermoplastics 827
Sawing laminates 514
Sawing thermoplastics 825
Screw machine and turret-lathe work 516
Shaving laminates 517
Shearing, blanking, punching 827
Shearing laminates 514
Tapping laminates 515
Thermoplastics, machining .. 824
Tool design and operation .. 824
Turning, threading, tapping . 826
Welding, hot-gas 838

FABRICS
Cotton reinforcements .. 478, 481
Glass reinforcements 472
Macerated, as fillers 469
Nonwoven fabrics 479
Synthetic fiber reinforcements 478
Woven 480

FIBERS (*See also Fabrics and Fibers Chart*)
Polyester 145
Synthetic and cellulosic 478
FIBERS CHART 580

FIBROUS GLASS, PREFORMING 523

FIBROUS GLASS REINFORCEMENTS 472
Economics, costs 477
Fiber surface 472
Finishes, types and sources (Table) 474
Manufacture 472
Mats 474, 475
Rovings 474, 477
Woven fabrics 476
Yarn nomenclature 476
Yarns, use of 475

FILLERS (*See also specific materials*)
Alpha-cellulose 469, 471
Asbestos 469, 470
Carbon black 470
Cotton 469, 471
Diatomaceous 470
For adhesives 184
For electrical potting and encapsulation 756
Glass 470
Graphite 470
Impact values 468
Keratin products 469
Lignin 469
Mica 470
Nylon 470
Macerated fabric 469
Paper, chopped 469
Properties of 470
Shell 469
Sisal fiber 469
Soybean meal 469
Types of (Table) 470
Wood flour 469

FILLERS AND REINFORCEMENTS 468

FILM AND SHEETING (*See also Films Chart*) 434
Acrylic 438, 439, 441, 742
Calendering 906, 907
Cellulose acetate ... 437, 440, 741
Decorating 444, 445
Extrusion of 709, 901
Laminates 442
Low-pressure laminating resins chart 590
Manufacturers of 1018
Physical properties of formable rigid sheets (Table) .. 441
Polyesters 145
Polyethylene .. 116, 437, 440, 441
Rubber hydrochloride 163
Styrene copolymers 440, 741
Vinyls 434, 440, 729, 742

FILMS CHART 559

FINISHING (*See Fabricating and Finishing*)

FLAMMABILITY
Properties chart ..... *facing* 554

FLEXURAL STRENGTH
Properties chart ..... *facing* 554

FLUORIDES (*See Fluorothene, Bakelite; Kel-F; Teflon*)

FLUOROETHYLENE POLYMERS 119

FLUORORUBBERS 162

FLUOROTHENE, BAKELITE
Properties chart ..... *facing* 554

FOAMED PLASTICS (*See also Expanded Plastics and Foaming Plastics*) 334
Cellulose acetate 343
Epoxy 110, 358
Flexible foam 340
Phenolics 136, 352
Polyethylene 350
Polystyrene 344
Polyurethane 339
Preparation of 338, 341, 344, 348, 349, 351, 354, 357
Rigid foams 340
Silicone 356
Syntactic foam 353
Use in sandwich constructions 527
Vinyls 167, 334

FOAMED PLASTICS CHART 556

FOAMING PLASTICS
Foaming agents 359
Polystyrene foams 155

FORMING 15, 736
Mechanical forming thermoplastic sheet 740
Plug and ring 740
Pressure forming 739
Rigid thermoplastic sheets .. 440
Slip ring 740

FOUNDRY INDUSTRY
Phenolic resin usage 138

FURANE RESINS 121
Adhesives chart 564
Chemistry 121
Coatings chart 572
Manufacturers of 1018
Processes 121
Properties chart ..... *facing* 554
Properties of 121

FURFURAL (*See Furane Resins*)

FURFURYL ALCOHOL (*See Furane Resins*)

G

GLASS
Fibers chart 580
Fibrous, manufacture of 473
Fibrous, preforming of 523
Fillers 470
Laminates chart 586
Reinforcements, fibrous 472

GLOSSARY 16

GLUE AND GLUING (*See Adhesives*)

GRAPHITE (*See Fillers*)

GRINDERS 909
Manufacturers of 1018

GR-S 156, 159, 440

H

HARDNESS
Properties chart ..... *facing* 554

HEAT CONDUCTIVITY
Properties chart ..... *facing* 554

HEAT DISTORTION
Properties chart ..... *facing* 554

HEAT-SEALING
Electronic 337, 924
Equipment for 924
High-frequency 924
Resistance 924

HEATING
Extruders 900
Mold and preform temperatures 686, 687, 691, 700, 703, 890
Molding machine cylinders . 894
Preheating alkyds 685
Preheating, dielectric 892
Preheating melamine molding compounds 686
Preheating phenolics 698
Vacuum forming, heaters for 736, 741

HOBBING PRESSES 910
Manufacturers of 1018

HYDROXYETHYL CELLULOSE 97
Adhesives chart 564
Characteristics 101
Coatings chart 572
Preparation of 97

I

IMPACT STRENGTH
Properties chart ..... *facing* 554

INDEX OF REFRACTION
Properties chart ..... *facing* 554

INJECTION MOLDING ... 13, [illegible]
Acrylics ..... [illegible]
Annealing of molded parts ..... 654, [illegible]
Control equipment ..... [illegible]
Equipment for ..... [illegible]
Gates, restricted ... 654, 657, [illegible] 662, 664, 669, 671, 677, 678, [illegible]
General operation ..... [illegible]
Kel-F ..... [illegible]
Mold design ..... 654, 656, [illegible] 660, 663, 669, [illegible]
Mold temperature ..... [illegible]
Molding temperatures for acrylics 658
Molding temperatures for cellulosics 659
Molding temperatures for Kel-F 661
Molding temperatures for nylon 664
Molding temperatures for polyethylene 666, 669, 671
Molding temperatures for polystyrene 671, 673, 674, 675, 677, 678
Molding temperatures for vinyls 680
Nylon 662
Polyethylene 115, 666
Polystyrene 671
Reinforced plastics 518, 521
Styrene 157
Styrenes, special 672
Time-saving devices 893
Vinyls 678

INORGANIC PLASTICS 122
Ceramoplastic materials 122
Cold molded 122
Glass bonded mica 122

INSERTS
Manufacturers of 1018

INSTRUMENTATION
Control equipment 890

INSULATION, BUILDING ... 353

ION EXCHANGE RESINS .. 123
Acrylic based 89
Applications of 124
Equipment and operation ... 124
Manufacture of 123
Manufacturers of 1018
Pharmaceutical uses 125
Properties of 123
Reactions 123
Sugar refining, use in 124
Types of 123
Uranium recovery 124
Water conditioning 124

ISOBUTYLENE-DIOLEFIN RUBBER 160
Coatings chart 572

ISOCYANATE RESINS 126
Adhesives 128, 182

pplications of 126
oatings 127
lastomers 128
oams 127
Urethane foams 127

IZOD IMPACT STRENGTH
Properties chart ..... *facing* 554

K

KEL-F 120
Characteristics of 120
Extrusion of 712
Films chart 559
Injection molding 661
Molding temperatures 661
Properties chart ..... *facing* 554

KERATIN PRODUCTS
(*See Fillers*)

L

LABORATORY PRESSES
Manufacturers of 1018

LACQUERS (*See Coatings*)

LAMINATES (*See also Laminates Chart and Laminating*) 506
Acetate film 442
Aluminum foil to plastic film 10
Applications of 442, 443, 508
Asbestos, use in 483
Epoxy 110, 510
Glass-Teflon laminates 510
High-pressure laminates: background 506
High-pressure laminates: special grades 510
Laminated sheets: military and NEMA grades (Table) 511
Low-pressure 513
Machining 514
Manufacturers of 1018
Melamine resins in 95
Molded laminates 508, 509
Polyesters in 142
Printed circuits 511
Properties chart ..... *facing* 554
Properties of 442, 443
Properties of (Table) 509
Reinforcements, cotton .. 478, 481
Reinforcements, nonwoven fabrics or mats 479
Reinforcements, synthetic fiber 478
Reinforcements, textile fibers, properties of (Table) 479
Reinforcements, woven fabrics 480
Rods 508
Silicone 150, 511
Tubes 508
Types of 442
Vinyl foam structures 337

LAMINATES CHART 586

LAMINATES AND REINFORCED PLASTICS (*See Reinforced plastics*)

LAMINATING 506
Equipment for 901
Low-pressure laminating resins chart 590
Methods of 442
Phenolic resins 137
Rods 902
Tubes 902

LATHES 907
Manufacturers of 1018

LEATHER
Acrylic based coatings 90

LIGNIN
Filler, use as 469
Laminates chart 586
Manufacturers of 1018

LOSS FACTOR
Properties chart ..... *facing* 554

LOW-PRESSURE LAMINATING (*See Laminates, Laminating, and Reinforced Plastics*)

LOW-PRESSURE LAMINATING RESINS CHART 590

LUBRICANTS
Mold 829
Silicone 150

LUMINESCENT MATERIALS
Manufacturers of 1018
Theory of 373

M

MACHINERY AND EQUIPMENT (*See also specific items*)
Manufacturers of 1018

MACHINING (*See also specific materials*)
Adhesive bonding 818
Ashing and buffing 827
Broaching laminations 517
Buffing laminates 517
Drilling laminates 515
Drilling thermoplastics 826
Filing thermoplastics 827
Finish wheels 827
Flycutting laminates 515
Gear cutting, plastics laminates 516
Grinding rod stock 827
Grinding tubes and rods 517
Laminates 514
Lathe operations on laminates 516
Milling laminates 515
Planing and shaping laminates 516
Polishing 517, 828, 911
Punching laminates 516
Sanding and grinding laminates 517
Sanding thermoplastics 827
Sawing laminates 514
Sawing thermoplastics 825
Screw machine and turret-lathe work 516
Shaving laminates 517
Shearing, blanking, punching 827
Shearing laminates 514
Tapping laminates 515
Thermoplastics 824
Tool design and operation .. 824
Turning, threading, tapping . 826
Welding, hot-gas 838

MAGAZINES 615

MELAMINE RESINS 94
Adhesives 95, 181
Applications of 94
Coatings 95
Coatings chart 572
Compression molding of 686
Decorative use of 688
Fillers for 94
Laminates, use of 95
Laminates chart 586
Manufacturers of 1018
Properties chart ..... *facing* 554
Textile treatments 95

METALIZING 834
Cathodic sputtering 837
Characteristics and use 834
Chemical reduction 837
Design for 835
Electroplating 837
Equipment and plant 836
Inlay processes 837
Surface preparation 835

METHYL CELLULOSE
Adhesives chart 564
Manufacturers of 1018

METHYL METHACRYLATE (*See Acrylics*)

MICA
Fillers 470
Glass bonded 122
Manufacturers of 1018
Properties chart ..... *facing* 554

MILLING (*See Machinery*)

MILLING MACHINES 908
Manufacturers of 1018

MODELS
Manufacturers of 1018

MOLD LUBRICANTS 829

MOLDING (*See also specific type*)
Plastisols 760
Slush molding 762

MOLDING COMPOUNDS
Epoxy based 111
Melamine formaldehyde 94
Silicone 150
Urea formaldehyde 91

MOLDING COMPOUNDS, FILLERS FOR 468

MOLDS (*See also specific types*)
Alkyds, compression 684
Casting, acrylics 747
Design for acrylics 656
Design for cellulosics 658
Design for nylon 663
Design for phenolics 700
Design for polyethylene 669
Design for urea 691
Design for Teflon 696
Design for vinyls 680
Electrical potting 757
Lubricants for 829
Manufacturers of 1018
Mold making, equipment for 907
Plastisols 758, 760
Plunger 682, 700
Tooling 744

MONOFILAMENTS (*See Fibers*)

MYCALEX
Properties chart ..... *facing* 554

N

NATURAL GAS
Use in plastics industry 366

NATURAL RESINS 129
Accroides 129
Adhesives chart 564
Amber 129
Asphalts 129
Cashew 129
Coatings chart 572
Copals 129
Damars 129
East Indias 129
Rosin 129
Shellac 129
Vinsol 129

NEOPRENE RUBBER 161
Adhesives chart 564

NITRILE RUBBER 160

NYLON RESINS 130
Applications of 132
Coatings 133
Coatings chart 572
Extrusion of 717
Fibers chart 580
Filler, use as 470
Films chart 559
Injection molding 662
Laminates chart 586
Laminates, use in 478
Machining 825, 827
Manufacturers of 1018
Mechanical parts, use for ... 133
Molding temperatures 664
Molds for 663
Processing 131
Properties chart ..... *facing* 554
Properties of 130
Types of (Table) 132

O

OIL-REACTIVE ESTER RESINS
Coatings chart 572

OLEORESINOUS MATERIALS
Adhesives chart 564
Coatings chart 572

OPTICAL PROPERTIES
Properties chart ..... *facing* 554

ORGANOSOLS
Composition and use 166, 178

P

PAINTS (*See also Coatings*)
Alkyd resins in 144, 177
Styrene resins in 178
Used in decorating 829
Vinyl resins in 178

PAPER
Chopped, as filler 469
Coating with nylon 719

PAPER TREATMENT
Melamine resins for 95

PEANUT PROTEIN 146

PETROLEUM
Petrochemicals in plastics .. 366

PETROLEUM RESINS 104
Sources of 104
Uses of 104

PHENOL-FORMALDEHYDE RESINS (*See also Phenolic Resins*)
Potting of electrical components 753

PHENOL-FURFURAL RESINS 138
Properties chart ..... *facing* 554

PHENOLIC RESINS 135
Adhesives 137, 181
Adhesives chart 564
Bonding agents 138
Bonding of 822
Casting 137, 752
Chemistry and manufacture 135, 176
Coatings 137, 177
Coatings chart 572
Compression molding of 698
Foamed phenolics 136
Foams 352
Forms of 136
Foundry use 8
Laminating uses 7
Low-pressure laminating resins chart 90
Manufacturers of 1 18
Molding compounds 36
Molding compounds, fillers for 71
Properties chart ..... *facing* 54
Tooling, use in 743

PHOSPHORESCENT PIGMENTS (*See Luminescent Materials*)

PHTHALIC ACID RESINS (*See Alkyd Resins*)

PHYSICAL PROPERTIES
Properties chart ..... *facing* 554

PIGMENTS (*See Color and Coloring*)

PIPES (*See Tubes and Pipes*)

PLANING MACHINES 907
Manufacturers of 1018

PLASTICIZERS 381
Functions of 381
Mechanism of plasticization . 381
Polyester 145
Polyvinyl chloride compounds 166
Types of 383

PLASTICIZERS CHART 598

PLASTICS, PRIMER OF 10

PLASTICS PROPERTIES CHART ..... *facing* 554

PLASTICS TOOLING 743

PLASTIGELS 166

PLASTISOLS
Dip molding 761
Low-pressure injection molding 767
Manufacturers of 1018
Molding of 758, 760
Rotational molding of 765
Use with vinyl chloride resins 166

PLUNGER MOLDING 681, 698, 699

POLISHING (*See Fabricating and Finishing; also Machining*)

POLYACRYLIC ESTERS (*See Acrylics*)

POLYACRYLONITRILE (*See Acrylonitrile Resins*)

POLYAMIDE RESINS (*See Nylon*)

POLYBUTADIENE (*See Butadiene Polymers and Copolymers*)

POLYCAPROLACTAM NYLON, EXTRUSION OF .. 721

POLYCHLOROTRIFLUOROETHYLENE (*See Kel-F*)

POLYESTER RESINS (*See also Alkyd Resins*) 140
Adhesives 182
Adhesives chart 564
Castings 143, 752
Chemistry 140
Commercial polyesters 143
Fabricating methods 140
Fiber and film 145
Film 439
Film, Mylar 145
Laminates 142, 518
Low-pressure laminating resins chart 590
Manufacturers of 1018
Molding compounds 140
Mylar film 145
Plasticizers 145
Potting and encapsulation of electrical components 753
Polyurethane formation 145
Premix of 143
Preparation of 140
Properties and uses 142
Properties chart ..... *facing* 554
Reinforced plastics, use in .. 518

POLYETHYLENE 112
Applications of 115, 118
Bottles and tubes 118
Branched polyethylene 441
Cellular 350
Coatings 117, 175, 179
Coatings chart 572
Electrical insulation, use in 116
Extrusion of 116, 732
Filaments 118
Film and sheeting .. 116, 437, 441
Films chart 559
Foam 350
High-density 115, 441
High-modulus 441
Injection molding 115, 666
Intermediate-density 114
Laminates chart 586
Linear polyethylene 441
Low-density 114
Low-pressure 441
Machining 825, 827
Manufacturers of 1018
Molding temperatures 666, 669, 671
Pipe 117
Properties chart ..... *facing* 554
Properties of 112
Vacuum forming 741
Welding 838
Wire extrusion 735

POLYINDENE (*See Coumarone-Indene Resins*)

POLYISOCYANATE (*See Isocyanate*)

POLYMERS, VINYL (*See Vinyl Polymers and Copolymers*)

POLYMETHYL METHACRYLATE (*See Acrylics*)

POLYSTYRENE (*See Styrene*)

POLYSULFIDES 161
Adhesives chart 564
Coatings chart 572
Properties chart ..... *facing* 554

POLYTERPENE RESINS 104
Characteristics 104
Coatings chart 572
Manufacturers of 1018
Uses of 104

POLYTETRAFLUOROETHYLENE (*See also Teflon*) ... 119
Films chart 559
Manufacturers of 1018
Processing methods 120
Properties of 119

POLYTRIFLUOROCHLOROETHYLENE (*See Kel-F*)

POLYURETHANE RESINS 126, 390
Adhesives 128
Coatings 127
Foams 127, 339
Polyesters in 145

POLYURETHANE RUBBERS 162

POTTING AND ENCAPSULATION OF ELECTRICAL COMPONENTS 753

POWER FACTOR (*See Dissipation Factor*)

PREFORMING OF FIBROUS GLASS 523

PREFORMS AND PREFORMING
Alkyds 685, 924
Asbestos 483
Compression molding .. 685, 686, 691, 694, 695, 696
Equipment for 918
Machines for 924
Material characteristics 921
Presses 918
Reinforced plastics 918, 924, 926
Teflon 725

PRIMER OF PLASTICS 10

PLANING MACHINES .. 516, 907

PRINTING
Flexographic 451
Gravure 448
Inks 447
Letterpress 452
Overprinting 450
Plastisol island 453
Processes of 448
Reverse 451
Silk screen 453
Spanishing 451
Stencil 452
Surface printing 451
Top coating 453
Transfer 451
Valley 451

PROCESSING (*See specific materials*)

PROPERTIES (*See Properties Chart and specific materials and properties*)

PROTEIN PLASTICS 146
Adhesives chart 564
Casein 147
Fibers chart 580
Peanut 146
Soybean 146
Zein 146

PYROMETERS
Manufacturers of 1018

PYROXYLIN (*See Cellulose Nitrate*)

R

REFRACTION, INDEX OF
Properties chart ..... *facing* 554

REINFORCED PLASTICS . 15, 513
Casting 752
Equipment for 926
Fibrous glass reinforcements 472
Injection molding 521
Materials 518
Molding, autoclave 519
Molding, bag 519
Molding, contact 519
Molding, dies for 522
Molding, matched die 520
Molding of 518
Molding, pressure 519
Molding, vacuum injection .. 520
Molds, dies for 522
Premixes and prepregs 521

REINFORCED PLASTICS AND LAMINATES 506

REINFORCEMENTS (*See Fillers, Laminates, and Reinforced Plastics*)

RESIN ASBESTOS COMPOSITIONS (*See Asbestos*)

RESINS (*See specific materials*)

RESINS AND MOLDING COMPOUNDS 86

RESINS FOR ADHESIVES ... 180

RESINS FOR COATINGS 175

RESISTANCE, CHEMICAL
Properties chart ..... *facing* 554

RESISTIVITY
Properties chart ..... *facing* 554

RESORCINOL FORMALDEHYDE RESINS 139
Adhesives 139, 181
Adhesives chart 564
Characteristics of 139
Manufacturers of 1018
Uses of 139

ROSIN (*See Natural Resins*)

RUBBER, CHLORINATED .. 163
Adhesives chart 564
Coatings chart 572
Properties chart ..... *facing* 554
Stabilizer requirements 380

RUBBER, CYCLIZED 163
Adhesives chart 564

RUBBER, HYDROCHLORIDE 163
Films chart 559

RUBBER, NATURAL AND SYNTHETIC (*See also specific rubber compounds*) 159
Acrylic esters in synthetic rubber 89
Adhesives 182
Adhesives chart 564
Butadiene/acrylonitrile copolymers 160
Butadiene/styrene copolymers 156, 159
Butyl 160
Chlorosulfonated polyethylene (Hypalon) 162
Coatings chart 572
Cold GR-S 159
Depolymerized 163
Fluororubbers 162
GR-S 156, 159, 440
Hot GR-S 159
Manufacturers of 1018
Neoprene 161
Nitrile 160
Polyacrylic 161
Polysulfides 161
Polyurethane rubbers 162
Properties chart ..... *facing* 554
Rubber derivatives 163

RUBBER, SILICONE 149, 162
Coatings chart 572

S

SANDING (*See Fabricating and Finishing*)

SANDWICH CONSTRUCTIONS 525
Adhesives in 525
Cellulose acetate in 344
Core materials 525
Facing materials 525
Panels 526, 527
Silicone powders in 356
Uses of 526, 527

SARAN (*See Vinyl Polymers and Copolymers*)

SAWING (*See Fabricating and Finishing, Machining, and specific materials*)

SCREWS (*See also Extrusion*)
Manufacturers of 1018

SEALING (*See Cementing, Heat-Sealing*)

SHAPING MACHINES 907
Manufacturers of 1018

SHEET FORMING (*See Forming*)

SHEETING (*See Film and Sheeting*)

SHELL FILLERS (*See Fillers*)

SHELLAC 129
Adhesives chart 564
Coatings chart 572
Manufacturers of 1018
Properties chart ..... *facing* 554

SHRINKAGE OF MATERIALS
Compression molding ... 684, 688, 691, 696, 701, 702
Properties chart ..... *facing* 554

SILICA (*See Fillers*)

SILICONE RESINS 148
Adhesives 150
Adhesives chart 564
Applications of (Chart) 151
Coatings chart 572
Electrical insulation, use in 149, 151
Fluids 149
Foam 150, 356
Foaming powders 150
Greases 150
Laminates 511
Laminates chart 586
Laminates, use of 150
Lubricants 150
Manufacturers of 1018
Manufacturing processes ... 148
Molding compounds 150
Properties of 148
Rubber 149
Varnishes 151
Water repellent 148

SILICONE RUBBER (*See Rubber, Silicone*)

SILK SCREENING 453, 831

SISAL
Filler, use as 469
Reinforced plastics, use in .. 518

SLUSH MOLDING 166, 762

SODIUM CARBOXYMETHOL CELLULOSE (*See Carboxymethol Cellulose*)

SOLVENTS ..... 385, [illegible]8
Adhesives ..... [illegible]3
Developments of ..... 385, [illegible]9
Production statistics (Table) [illegible]6
Use as resin intermediates .. [illegible]6

SOYBEAN PLASTICS ..... [illegible]46
Adhesives chart ..... [illegible]64
Use as filler ..... [illegible]69

SPECIFIC GRAVITY
Properties chart ..... *facing* 554

SPONGE PLASTICS (*See Expanded Plastics*)

STABILIZERS 377
Chelators 378
Epoxy resins 380
Metal-type stabilizers ... 377, 379
Types of 379

STATISTICS 535

STRENGTH (*See Specific Properties*)

STYRENE POLYMERS AND COPOLYMERS 152

STYRENE RESINS 152
Acrylonitrile type ... 155, 156, 440
Alkyl-substituted 155
Annealing 828
Applications of 158
Butadiene types 156, 436, 440
Calendering 157
Chemical-resistant 154
Chemistry and manufacture 157
Coatings 178
Colorants for 368
Decorating 153
Destaticization of styrene ... 374
Expanded 155, 344, 347
Extrusion of 152, 157
Film and sheeting 440, 741
Films chart 559
Foams 155, 344
Glass-reinforced 154, 675
High-impact 827
Impact type 154
Injection molding 157, 671
Light-stable formulations .. 153
Molding 152
Molding temperatures .. 671, 673, 674, 675, 677
Oriented 155, 437, 742
Polystyrene, applications of . 153
Polystyrene, bonding of 820
Polystyrene, properties of .. 153
Processing of 349
Properties of polystyrene and styrene alloys (Table) ... 158
Rubber-resin blends 156, 436
Types of 153

SYNTHETIC AND CELLULOSIC FIBERS 478

SYNTHETIC RUBBER (*See Rubber, Natural and Synthetic*)

T

TECHNICAL DATA CHARTS (*See specific subjects*)

TEFLON
Compression molding of 694
Extrusion of 724
Preforming of 694, 725
Toxicology of 698

TENSILE STRENGTH
Properties chart ..... *facing* 554

TETRAFLUOROETHYLENE (*See Teflon*)

TEXTILE TREATMENTS
Acrylic resins for 89
Melamine resins for 95
Urea formaldehyde for 92

THERMAL CONDUCTIVITY
Properties chart ..... *facing* 554

THERMAL EXPANSION
Properties chart ..... *facing* 554

THERMAL PROPERTIES
Properties chart ..... *facing* 554

THERMOFORMING, RIGID SHEETS FOR (*See Forming*)

THERMOPLASTIC SHEET FORMING (*See also Forming*) 736

THERMOPLASTICS (*See also specific materials*)
Definition of 10

THERMOSETS (*See also specific materials*)
Casting 750
Definition of 10

TOOLING
Epoxy fabrications 110
Plastics tooling 743

TOOLS, PLASTICS 752

TRANSFER MOLDING .. 681, 698
Alkyds 684
Control equipment 891

TUBES AND PIPES
Laminating tubes, equipment for 902
Polyethylene 117
Tubing extrusion from nylon 718
Tubing extrusion from polycaprolactam nylon 721
Tubing extrusion from polyethylene 732
Tubing extrusion from Teflon 725

U

URANIUM RECOVERY 124

UREA RESINS 91
Adhesives 92, 181
Adhesives chart 564
Coatings chart 572
Compression molding of 690
Manufacturers of 1018
Molding compounds, fillers for 471
Production of 91
Properties chart ..... *facing* 554
Urea formaldehyde in 94

URETHANE (*See Polyurethane Resins*)

V

VACUUM FORMING
Drape forming 736
Extrusion process 739
Female forming 738
Male forming 737
Molds for 738
Snap-back forming 739
Thermoplastic sheet forming 736

VACUUM METALIZING (*See Metalizing*)

VARNISH (*See Coatings*)

VINYL POLYMERS AND COPOLYMERS 164, 177
Adhesives 182
Adhesives chart 564
Applications of 167, 168, 169, 170, 173, 177, 178
Bonding of 820, 822
Chemistry and manufacture . 177
Coatings 177
Coatings chart 572
Colorants for 368
Electrical insulation, use in . 167
Extrusion of 172, 727
Fibers chart 580
Film and sheeting 434, 440, 729, 742
Films chart 559
Foams 167, 334
Injection molding 678
Manufacturers of 1018
Organosols 166, 178
Plastisols, molding .. 759, 760, 762
Polymerization, methods of . 164
Polyvinyl acetals 169
Polyvinyl acetate ... 168, 177, 178
Polyvinyl alcohol ... 169, 177, 436
Polyvinyl alkyl ethers 170
Polyvinyl butyral 175, 178
Polyvinyl carbazole 170
Polyvinyl chloride .. 165, 177, 338, 377, 383, 434, 440, 727, 838
Polyvinyl chloride-acetate 168, 177, 820
Polyvinyl formal 169
Polyvinyl pyrrolidone 170
Polyvinylidene chloride 169
Polyvinylidene copolymer film 436
Properties chart ..... *facing* 554
Properties of 165, 168, 169, 172, 177
Rigid vinyls 171, 435, 440, 679, 742, 820, 827
Saran (vinylidene chloride) 177, 178
Solvents for 388
Vinyl ether, alkyl 170

VULCANIZED FIBRE 174
Grades of 174
Laminates chart 586
Manufacturers of 1018
Properties chart ..... *facing* 554
Properties of 174

VULCANIZED RUBBER (*See Rubber, Natural and Synthetic*)

W

WAXES
Adhesives chart 564
Coatings chart 572

WELDING PLASTICS 838

WIRE COATING 713, 718, 726, 730, 735

WOOD FLOUR (*See Fillers*)

WOOD, MODIFIED
Manufacturers of 1018

Y-Z

YARN (*See Fibers; also Fibrous Glass Reinforcements*)

ZEIN 146, 147
Adhesives chart 564
Applications of 147
Fibers chart 580
Processing and Lubricating . 146

Advertisers' Index

RESINS AND MOLDING COMPOUNDS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 86.

ACRYLIC
du Pont de Nemours, E. I. & Co., (Inc.), Polychemicals Dept. 65-84
Gering Products, Inc. 317
Imperial Chemical Industries Ltd. 232
Peters Chemical Mfg. Co. 320
Rohm & Haas Company 309-316

ADHESIVES
American Cyanamid Co., Plastics & Resins Div. 215-230
Angier Adhesives, Div. Interchemical Corp. 238
Furane Plastics Incorporated 320
Monsanto Chemical Company, Plastics Div. .. 239-250
Reichhold Chemicals, Inc. 58, 231
Rubber & Asbestos Corp. 214

ALKYDS
Allied Chemical & Dye Corp., Barrett Div. ... 209-212

CAST SHEETS
Rohm & Haas Company 309-316

CELLULOSE ACETATE
American Molding Powder & Chemical Corporation 272
Celanese Corporation of America, Plastics Div. 321-324
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Eastman Chemical Products, Inc. 326, 327
Gering Products, Inc. 317
Monsanto Chemical Company, Plastics Div. .. 259-270

CELLULOSE ACETATE BUTYRATE
American Molding Powder & Chemical Corporation 272
Eastman Chemical Products, Inc. 326, 327
Gering Products, Inc. 317

CELLULOSE NITRATE
Monsanto Chemical Company, Plastics Div. .. 239-250

CELLULOSE PROPIONATE
Celanese Corporation of America, Plastics Div. 321-324

COATINGS, EMULSIONS, DISPERSIONS
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Durez Plastics Div., Hooker Electrochemical Co. 43-46, 300-301
Furane Plastics Incorporated 320
Michigan Chrome and Chemical Co. 278
Monsanto Chemical Company, Plastics Div. .. 239-250
National Polymer Products, Inc. 251
Polymer Processes, Inc. 206
Polypenco, Inc. 206

COLORANTS
American Molding Powder & Chemical Corporation 272
Gering Products, Inc. 317
Goodrich, B. F., Chemical Company 279-290
Reichhold Chemicals, Inc. 58, 231
Westchester Plastics, Inc. 299

CUSTOM COMPOUNDING
American Molding Powder & Chemical Corporation 272
Gering Products, Inc. 317
Westchester Plastics, Inc. 299

DIALLYL PHTHALATE
Acme Resin Corporation 184
FMC Organic Chemicals Div., Food Machinery and Chemical Corp. 330

ETHYL CELLULOSE
Dow Chemical Company, The 49-56
Gering Products, Inc. 317

EPOXIES
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Ciba Company Inc., Plastics Div. 273-276
Furane Plastics Incorporated 320
Shell Chemical Corporation, Chemical Sales Div... 298

EXPORTERS & IMPORTERS
Interplastics Corporation 278
Omni Products Corporation 292
Polypenco, Inc. 206

FABRICS FOR COATING
Wellington Sears Co. 57

FILM, SHEETING, TUBING & RODS
Barron, J. E., Plastics, Inc. 257
Cadillac Plastic and Chemical Co. 47
Celanese Corporation of America, Plastics Div. 321-324
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Gering Products, Inc. 317
Monsanto Chemical Company, Plastics Div. .. 239-250
Polymer Corp. of Penna., The 206
Polypenco, Inc. 206

FLUOROCARBONS
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
du Pont de Nemours, E. I. & Co., (Inc.), Polychemicals Dept. 65-84

GLASS BONDED MICA
Mycalex Corporation of America 204, 205

INDUSTRIAL RESINS
Durez Plastics Div., Hooker Electrochemical Co. 43-46, 300, 301
Valite Corporation 308

MOLD MAKING MATERIAL
Bestwall Certain-Teed Sales Corporation 328

MOLDERS, FABRICATORS
Barron, J. E., Plastics, Inc. 257
Mycalex Corporation of America 204, 205

NYLON
Allied Chemical & Dye Corp., Barrett Div. 209-212
American Molding Powder & Chemical Corporation 272
Belding Corticelli Industries 325
Catalin Corporation of America 303
du Pont de Nemours, E. I. & Co., (Inc.), Polychemicals Dept. 65-84
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Fiberfil, Inc. 293-296
Gering Products, Inc. 317
National Polymer Products, Inc. 251
Polypenco, Inc. 206
Spencer Chemical Company 48, 64

ORGANOSOLS
Stanley Chemical Company 185

PHENOLICS
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Durez Plastic Div., Hooker Electrochemical Co. 43-46, 300-301
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Fiberite Corporation, The 208
General Electric Company 188-189
Imperial Chemical Industries Ltd. 232
Marblette Corporation, The 63
Monsanto Chemical Company, Plastics Div. .. 239-250
Plastics Engineering Company 332
Reichhold Chemicals, Inc. 58, 231
Rogers Corporation 237
Valite Corporation 308

PLASTICIZERS
Monsanto Chemical Company, Chemical Div. 59-62
United States Rubber, Naugatuck Chemical Div. 191-200

PLASTISOLS
Chemical Products Corporation 42
Michigan Chrome and Chemical Co. 278
Stanley Chemical Company 185
Watson-Standard Co. 183

POLYESTERS
Allied Chemical & Dye Corp., Barrett Division 209-212
American Cyanamid Co., Plastics & Resins Div. 215-230
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Celanese Corporation of America, Plastics Div. 321-324
Durez Plastics Div., Hooker Electrochemical Co. 43-46, 300-301
Glidden Co., The, Industrial Finishes Div. 213
Pittsburgh Plate Glass Co., Selectron Products Div. 190
Reichhold Chemicals, Inc. 58, 231
United States Rubber, Naugatuck Chemical Div. 191-200

POLYETHYLENE
Allied Chemical & Dye Corporation, Semet-Solvay Petrochemical Div. 331
American Molding Powder & Chemical Corporation 272
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Catalin Corporation of America 303
Celanese Corporation of America, Plastics Div. 321-324
Dow Chemical Company, The 49-56
du Pont de Nemours, E. I. & Co., (Inc.), Polychemicals Dept. 65-84
Eastman Chemical Products, Inc. 326, 327
Gering Products, Inc. 317
Grace, W. R., & Co., Polymer Chemicals Div. 306-307
Imperial Chemical Industries Ltd. 232
Koppers Company, Inc. 253-256
Monsanto Chemical Company, Plastics Div. .. 239-250
Muehlstein, H., & Co., Inc. 252, 277
Phillips Chemical Company, Plastic Sales Div. 297, 304
Schulman, A. Inc. 329
Spencer Chemical Company 48-64
U. S., Industrial Chemicals Co., Div., National Distillers and Chemical Corp. 186-187

REPROCESSORS
Erie Plastics Company, Inc. 278
Gering Products, Inc. 317
Holland, M., Company 258
Interplastics Corporation 278
Muehlstein, H., & Co., Inc. 252, 277
Woloch, George, Co., Inc. 258

SPECIALTY MOLD COMPOUNDS
Luminous Resins, Inc. 85

STYRENE & STYRENE BASED MATERIALS
American Cyanamid Co., Plastics & Resins Div. 215-230
American Molding Powder & Chemical Corporation 272
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Catalin Corporation of America 303
Dow Chemical Company, The 49-56
Fiberfil, Inc. 293-296
Foster Grant Co., Inc. Petrochemical Div. 201
Gering Products, Inc. 317
Koppers Company, Inc. 253-256
Marbon Chemical, Div. of Borg-Warner 291
Monsanto Chemical Company, Plastics Div. .. 239-250
Union Carbide International Company, Division Union Carbide Corporation 190A-B
United States Rubber, Naugatuck Chemical Div. 191-200

UREA & MELAMINE
Allied Chemical & Dye Corp., Barrett Division 209-212
American Cyanamid Company, Plastics & Resins Div. 215-230
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Fiberite Corporation, The 208
Imperial Chemical Industries Ltd. 232

VINYLS
American Molding Powder & Chemical Corporation 272
Bakelite Company, Div. Union Carbide & Carbon Corp. 259-270
Chemical Products Corporation 42
Chemore Corporation 271
Diamond Alkali Company 302
Dow Chemical Company, The 49-56
Dynamit-Actien-Gesellschaft Vormals Alfred Nobel & Co. 207
Escambia Chemical Corporation 305
Firestone Plastics Co., Chemical Sales Div. ... 202-203
General Tire & Rubber Co., The, Chemical Div. 318-319
Gering Products, Inc. 317
Goodrich, B. F., Chemical Company 279-290
Goodyear Tire & Rubber Co., Chemical Div. .. 233-236
Great American Plastics Co., Petro Chemical Div. . 308
Monsanto Chemical Company, Plastics Div. .. 239-250
Schulman, A., Inc. 329
Stanley Chemical Company 185
United States Rubber, Naugatuck Chemical Div. 191-200



chem-o-sol® *gives you unlimited potential thru*

The World's Most Advanced Research

The World's Most Experienced Formulator

The World's Only Application Methods Plant

The World's Largest Production Capacity



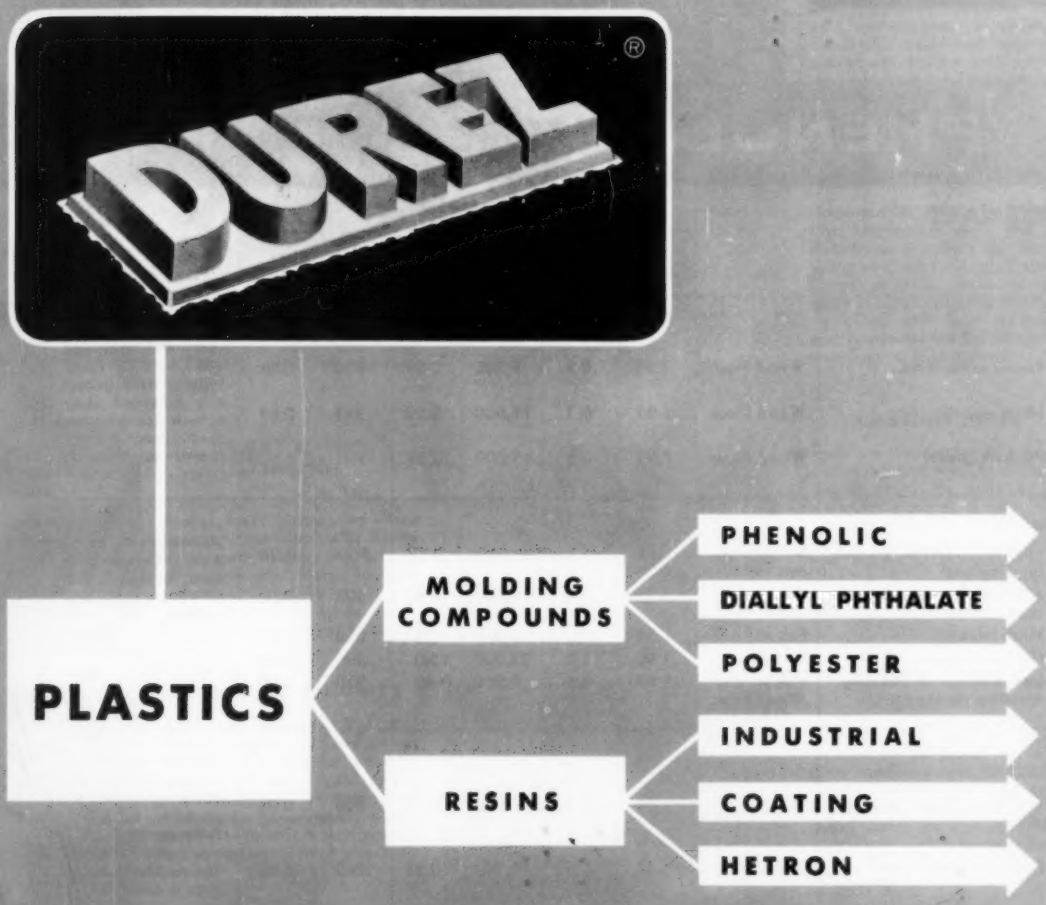
chem-o-sol® *is Super Plastisol . . .*

Chem-o-sol is our trade name for specially formulated polyvinyl dispersions (plastisols), which free the designer from the limitations of conventional materials. Inherently versatile because of their "liquid solid" nature, these dispersions offer unlimited opportunity to solve old problems and to develop new products, new forms, new characteristics. They are simple to apply, whether adapted as coatings and finishes or as shaped components.

To give you the ultimate in this new production tool, we operate the world's largest plant — with the most modern facilities for research, application method development, and production of specialized formulations.

Call on these facilities to improve your present production, create new products, open entirely new fields.

Chemical Products
CORPORATION
KING PHILIP ROAD • EAST PROVIDENCE, R. I.
Member Vinyl Dispersions Division of The S.P.I.



A primary evaluation of the properties of the Durez plastics, and the combinations in which they are available in molding materials and resins, can be obtained from the data on the following pages.

The variety of these modern materials and their consistent uniformity reflect the experience of 35 years in developing, producing, and applying plastics to the needs of industry.

Engineers and designers seeking further information on materials combining the characteristics they require are invited to call on this experience. It is available through qualified technical men who can often assist in solving design, structural, and production problems.

PLASTICS *that fit the job*

HOOKER ®
CHEMICALS
PLASTICS

DUREZ® PLASTICS

Durez thermosetting phenolics offer mechanical, electrical, thermal, and chemical properties in hundreds of combinations. Each fulfills, within its intended field of application, a given set of requirements. Compression, transfer, or plunger presses can be used. An economy factor is that many of the molding compounds can be molded on automatic equipment.

The industrial resins exhibit similar properties, and frequently improve the characteristics of other materials when used as bonding and impregnating media. Durez coating resins are oil soluble and have wide use in applications such as wax emulsions, brushing and spraying finishes, varnishes and enamels.

PHENOLIC Molding Compounds

MATERIALS		Filler	PROPERTIES: Specific Gravity	Water Absorption	Flexural PSI	Impact FP inch notch	°F Diel. Strength V/m-s/t	Power Factor 1000 KC	USES
GENERAL-PURPOSE									Cases, housings, cabinets, and large and small parts of many types where generally balanced characteristics are desired. These are the lowest cost phenolic materials.
265	Fastest production.	Wood Flour	1.38	0.5	9,000	0.27	350	0.04	
791	Most versatile.	Wood Flour	1.37	0.7	11,000	0.28	325	0.03	
11540	Highest quality.	Wood Flour	1.37	0.6	11,000	0.31	350	0.035	
IMPACT									Automotive pump gears, telephone parts, bushings, caster wheels, tool parts, pulleys, and other applications subject to rough handling or heavy wear in service.
1544	Highest impact in granular type material.	Wood Flour and Flock	1.37	0.7	11,000	0.37	350	0.04	
1900	Medium impact nodular type material.	Fabric	1.42	1.2	10,000	0.6	300	0.06	
14482	High impact.	Fabric	1.38	1.0	10,000	1.8	350	0.04	
16221	Highest impact.	Fiberglas®	1.90	1.0	22,000	17.0	350	0.02	
16840	Low modulus of elasticity —resilient.	Rubber and Wood Flour	1.29	1.6	8,200	0.45	375	0.09	
NON-BLEEDING									Closures for medicinal, cosmetic and other packaged products, especially those containing liquids with alcohol. The molded appearance is excellent.
3949	General-purpose, minimum odor.	Wood Flour	1.38	0.8	9,000	0.28	200	0.05	
3971	Fast cure, good finish.	Wood Flour	1.38	0.5	9,000	0.28	260	0.05	
ELECTRICAL									Automotive, radio, TV transformer, X-ray, switch, appliance, and other electrical equipment parts requiring excellent dielectric and low-loss values.
2271	High dielectric strength at elevated temperatures.	Wood Flour	1.37	0.7	10,000	0.28	350	0.03	
16090	Good arc resistance.	Mineral	1.67	0.4	8,500	0.36	400	0.05	
16274	Low dissipation factor, high volume resistivity.	Mineral	1.75	0.06	9,500	0.30	375	0.013	
HEAT-RESISTANT									Electric iron and cooking utensil handles, toaster and coffee-maker parts, and other applications where high heat resistance is needed for durability and safety.
55	Good impact strength with excellent heat resistance.	Mineral and Flock	1.61	0.5	8,500	0.36	300	0.14	
1308	Most versatile.	Mineral and Wood Floor	1.57	0.4	9,500	0.26	350	0.05	
14893	Highest resistance.	Mineral	1.54	0.2	8,000	0.25	275	0.12	
SPECIAL PROPERTY									Washing machine components, textile machinery parts, chemical-resistant moldings, pump impellers and similar parts, and other applications requiring unusual combinations of properties.
75	Maximum resistance to acids, mild alkalies.		1.38	0.4	8,000	0.20	230	0.045	
13856	Good impact, excellent resistance to water.	Flock	1.41	1.0	9,500	0.48	200	0.05	
14900	Good impact, dimensional stability, gloss, water resistance.	Flock	1.38	0.4	9,000	0.32	250	0.05	
15328	Non-corrosive, general purpose.	Flock and Wood Flour	1.38	0.7	9,000	0.28	325	0.04	







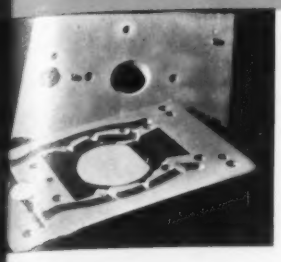






For information on Flame-Resistant Resins see data on HETRON®

PHENOLIC Industrial Resins



SHELL MOLDS FOR METAL CASTINGS

Improved phenolic foundry resins, including new types for coated sand, bring new efficiency and economy to the shell molding process. These resins produce shell molds and cores marked by exceptionally high strength, minimum curing cycles, and excellent pattern detail.



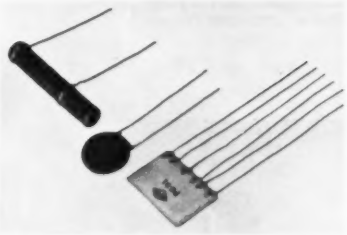
IN RUBBER COMPOUNDS

Durez resins are used in compounding stocks for shoe soles and heels, tool handles, and other moldings. Hardness, stiffness, and resistance to abrasion, chemicals, and heat are improved. Neoprene and acrylonitrile solvent-type cements are strengthened by the addition of Durez resins.



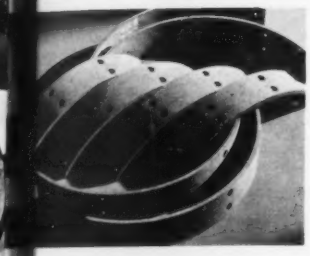
WOOD PARTICLE BONDING

Sawdust, shavings, and cuttings formerly wasted are mixed with Durez resin to make structural sheets and molded toilet seats, shoe forms, and other products. Resin helps make board sheets dense, strong, free from warp, and highly resistant to deterioration.



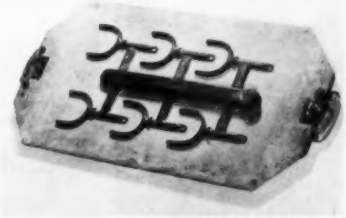
IN ELECTRICAL PARTS

Insulation for parts such as resistors, condensers, coils, and capacitors is provided by dense, strong coatings formulated with a Durez phenolic resin. In this material electrical properties are combined with heat insulation and freedom from the effects of exposure to high humidity.



BRAKE LINING BONDING

Automotive and aircraft brake linings, brake blocks, and clutch facings formulated with Durez resins wear longer. Stopping is easier and safer. Resins increase resistance to heat, water, oil, and grease. In lining-to-shoe bonds they eliminate the need for rivets.



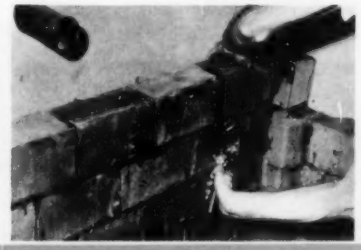
CASTING RESIN

Parts can be produced quickly and at low cost with Durez liquid casting resin. The resin is cast without the use of pressure, sets fast, requires only a mild bake, and is advantageous for short-run, model or prototype work, masking fixtures, novelty casting, foundry patterns, and special parts.



ABRASIVE BONDING

High heat resistance is an important property in Durez resins used to bind abrasive grains in grinding wheels, abrasive paper, and abrasive discs. Durez-bonded wheels can be run safely at unusually high speeds and operating temperatures, and give long service.



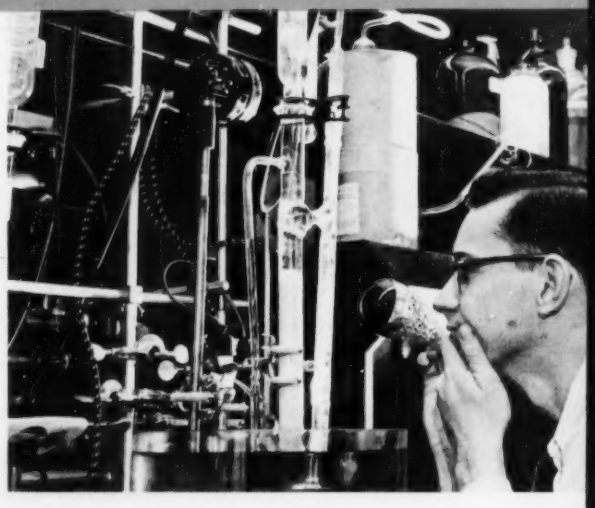
IN ACID-PROOF CEMENTS

Pickling tanks, fume stacks, absorption towers, floors, and other units lined with acid-proof brick require an equally acid-resistant cement. Durez furfuryl-alcohol resins in mortars enable such equipment to be used interchangeably in contact with acid or alkalies.

PHENOLIC Coating Resins

in WAX EMULSIONS, VARNISHES, PRINTING INKS, etc.

Coatings and finishes of many types are improved by formulation with Durez phenolic resins. The resins produce wax emulsions having excellent qualities of water resistance, wearability, slip resistance, and gloss retention. Resins for varnishes and enamels are soluble or readily dispersible in drying oils and improve the properties of brushing and spraying finishes with acid-, alkali-, and water-resistance, and durability. Durez resins are also useful in heat-set and gel-type printing inks.

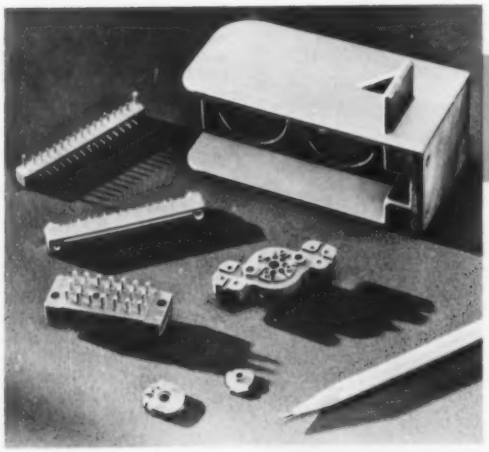


For information on Flame-Resistant Resins see data on HETRON®

COLORED POLYESTER
Molding Compounds

New horizons in product design were opened up with the development of Durez thermosetting polyester molding compounds in a full range of opaque colors. These materials possess exceptionally high dimensional stability when molded, and their excellent electrical properties include high arc resistance. Recommended for business machine parts, radio and TV cabinets, shaver housings, telephone handsets, appliance and utensil handles, and other applications requiring versatile engineering properties plus color. Available in three grades: general-purpose, general-purpose self-extinguishing, and improved impact. Can be molded on automatic presses.





DIALLYL PHTHALATE
Molding Compounds

These thermosetting molding materials are giving highly dependable service in electrical applications where exposure to high humidity for long periods is encountered. They do not corrode metal inserts. They have excellent dimensional stability. Very fine electrical properties, low water absorption, and high impact strength are notable among the characteristics shown in the table below:

MATERIAL		PROPERTIES						
	Filler	Specific Gravity	Water Absorption	Flexural PSI	Impact FP inch-notch	Heat resist °F.	Diel. Strength V/m-s/t	Power Factor 1000 KC
16694	Orlon	1.31	0.2	10,500	0.55	240	400	0.02
17877	Mineral	1.65	0.2	8,500	0.3	300	390	0.08

FURTHER INFORMATION

We will gladly supply information about any of these molding compounds, industrial resins, and coating resins if you will tell us your specific interests. Much helpful information and data are available in published literature. Write us for whatever you need.



GENERAL CATALOGS

- "Durez Phenolic Molding Compounds"
- "Durez Industrial Resins"

PERIODICALS

- "The Durez Molder"
- "Durez Plastics News"
- "Shell Mold News"

DISCUSSIONS AND STUDIES

- "Machining Data on Phenolic Plastics"
- "Durez Resins in the Rubber Industry"
- "Durez Guide to Resin Coated Sand"
- "Durez Casting Resin"

Plastics that fit the job

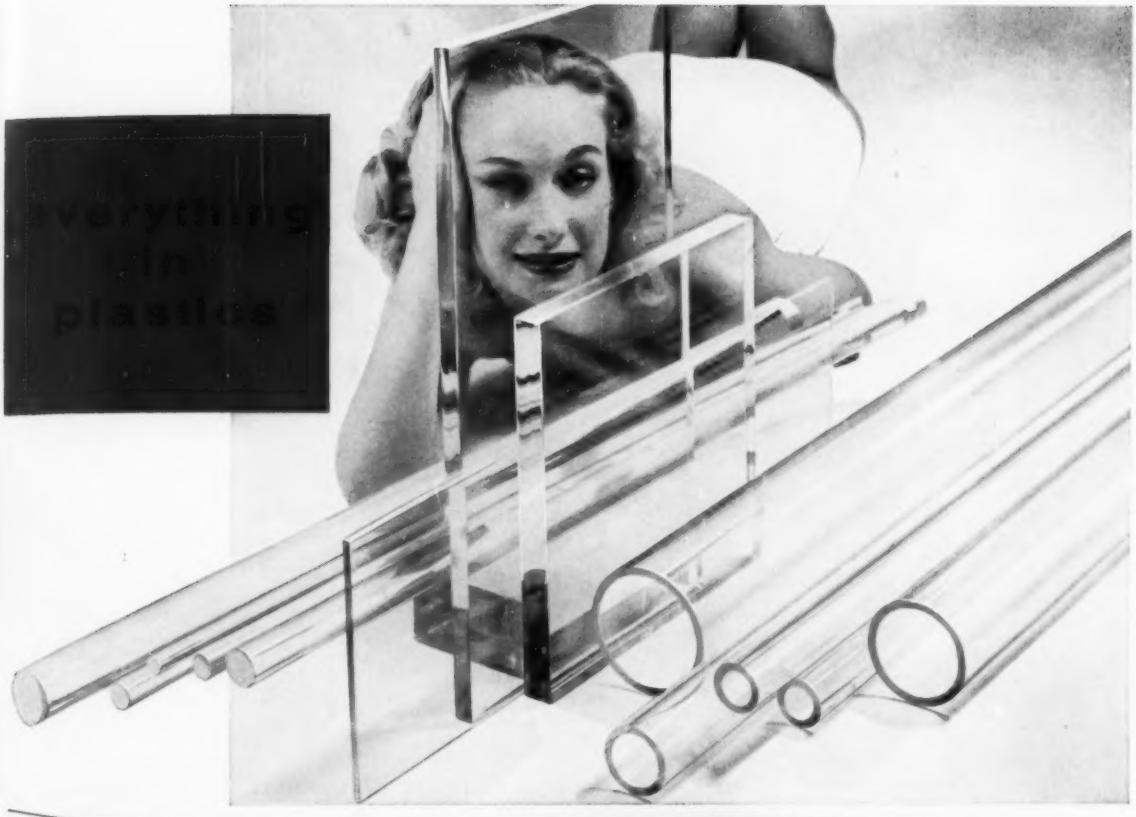
DUREZ PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

68 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICALS PLASTICS

District Sales Offices in New York, Chicago, Detroit, Philadelphia, Los Angeles



RODS SHEETS TUBES

PLEXIGLAS®
VINYLITE
NYLON
ACETATE
STYRENE
POLYETHYLENE
PHENOLICS
TEFLON
KEL-F
FIBERGLAS®

America's largest plastic stocks

We maintain warehouse inventories in every U. S. Time Zone. This assures you immediate delivery of every type of plastic material. Our engineering staff is always ready to help in solving your plastic problems.

"Cadco"® cast acrylic rods, tubes, block and extruded sheet

Our manufacturing division mass-produces a wide variety of "Cadco" material. "Cadco" is available optically clear and in modern decorator colors.

Free Booklets!

Cadillac Plastic and Chemical Co.

Gentlemen: Please send me the following booklets

- ☐ How to work with Plexiglas
- ☐ 157 Ways to use Plastics for maintenance.
- ☐ Fiberglas catalog and prices
- ☐ General catalog and prices.
- ☐ Fabrication data of "Cadco Extruded sheets

Name_____

Address_____ City_____

Company_____

®Registered Trademarks

cadillac plastic and chemical co.

15111 SECOND BLVD., DETROIT 3, MICHIGAN

727 Lake Street, Chicago 6, Ill.
2111 Olive Street, St. Louis 7, Mo.
517 N. Broadway, Milwaukee, Wis.
500 Santa Fe Bldg., Dallas, Texas
2305 Beverly Blvd., Los Angeles 57, Calif.
652 Polk St., San Francisco 2, Calif.
3333 Detroit Ave., Cleveland, Ohio

Look!

See what you can make with

Plastic-Light Metal-Tough Corrosion-Resistant Spencer Nylon



Many new profit opportunities are now waiting for you because of new Spencer Nylon's special advantages:

INJECTION MOLDING: Dozens of new profit opportunities are now open to manufacturers, because of new Spencer Nylon. For example, with Spencer Nylon it is now possible to injection-mold pieces that have large surface areas and thick cross sections. These pieces are amazingly light, yet durable as metal, and far more corrosion-resistant. New Spencer Nylon brings into range such multi-million pound uses as cases for portable radios, motor boat propellers, conveyor belt links and electric motor housings.

A problem with ordinary nylon has long been that it has a water-like viscosity at processing temperatures. And because it solidifies so quickly, molding large objects has been exceedingly difficult.

This problem is solved with new Spencer Nylon. Spencer Nylon has a wider plasticizing range, making it easier to handle and less likely to produce voids during molding. And because it has a wider temperature working range, it is less likely to degrade during processing.

EXTRUSION: Bigger nylon pipe, in diameters up to 6 inches, is possible with new Spencer Nylon, too—again because of superior processing qualities. Pipe made with new Spencer Nylon is unaffected by powerful chemicals, fats, oils and greases. (And because of Spencer Nylon's unusual properties, it is also ideally suited for coating wire and cable, for producing tubing and for extruding profiles.)

FILM: Spencer Nylon, which is unaffected by most hydrocarbons, extends the applications of plastic packaging materials into such fields as film pouches for oils and fats.

OTHER TECHNIQUES: Processing methods such as extrusion molding and centrifugal casting are possible with Spencer Nylon. Also, it is possible to weld or join Spencer Nylon with an adhesive.

ECONOMICAL: It often costs less to use Spencer Nylon instead of metal and other plastics. Compared with metal, its low specific gravity permits the production of more parts per pound. Manufacturing cost is cut by molding to close tolerances, rather than machine finishing.

FULL RANGE OF RESINS: Spencer's resins are designed for a wide variety of processing techniques and applications. This large family of resins has the closest-controlled specifications of any nylon. That's because it is made by continuous polymerization.

DON'T MISS YOUR SHARE of the profits in nylon's future. We'll be glad to advise you on new fields and markets. Just write to Spencer Nylon, Spencer Chemical Company, Dwight Bldg., Kansas City 5, Missouri.

NOW! NYLON *by* SPENCER

SPENCER

SPENCER CHEMICAL COMPANY

GENERAL OFFICES: DWIGHT BUILDING, KANSAS CITY 5, MISSOURI



America's First Family of Thermoplastics

DOW

STYRON

STYREX

SARAN

ETHOCEL

POLYETHYLENE

PVC RESINS

More formulations for
greater-than-ever versatility

EXCELLENT SURFACE FINISH • GOOD FLEXURAL STRENGTH • RESISTANCE TO SHATTERING AND CRACKING • HIGH IMPACT STRENGTH • HIGH HEAT DISTORTION • WIDE CHOICE OF GRANULATIONS • UNLIMITED COLOR RANGE

FOR VACUUM FORMING, EXTRUSION, CALENDERING, INJECTION MOLDING—Recognizing industry's need for up-to-date, improved molding materials, Dow consistently offers you the most complete line of polystyrenes in the industry. There are new general-purpose Styron materials with improved flow and extrusion properties. You also have a range of high-impact Styron formulations to provide better heat resistance properties, glossier surface, and better moldability, making many applications possible for the first time. Each of the specialized formulations has been proven a champion . . . in the laboratory, in fabricating, in use by consumers. For low moisture absorption characteristics, for parts demanding accurate dimensional stability, for superior fabrication properties—Styron is *the* polystyrene to satisfy your exact need. Check Dow and see!

STYRON® polystyrene

APPLICATIONS INCLUDE: RADIO CABINETS • APPLIANCE HOUSINGS • NUMEROUS INDUSTRIAL COMPONENTS • CUTLERY HANDLES • REFRIGERATOR COMPONENTS



APPLICATIONS INCLUDE: REFRIGERATION AND AUTOMOTIVE MATERIALS • BRISTLES • DENTURES • PENCIL BARRELS • DINNERWARE • AEROSOL

STYREX® a copolymer of styrene acrylonitrile

Excellent balance of physical properties

RIGID • CHEMICAL RESISTANT • GOOD HEAT RESISTANCE • HIGH CRITICAL ELONGATION • TOUGH • AVAILABLE WITH OR WITHOUT SURFACE LUBRICATION • IN NATURAL AND A WIDE RANGE OF TRANSPARENT AND OPAQUE COLORS • TAKES DECORATIVE COLORS AND FINISHES • EXCELLENT MOLDABILITY

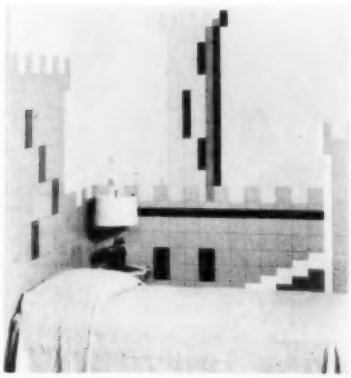
FOR MOLDING AND EXTRUSION—With the introduction of Styrex in 1956, new horizons opened up for the plastics industry. Rigid and combining an excellent balance of physical properties, this new copolymer of styrene acrylonitrile is finding increased use in automotive materials and food containers, in numerous applications from tumblers to dentures. It provides high critical elongation and tensile strength with good heat resistance and improved toughness. It resists acids, bases, salts, oils, waxes, soaps, food stains, and many solvents including gasoline and kerosene. Styrex, with its ease of fabrication coupled with its excellent properties, provides a versatile molding material for many uses.



Refrigerator Inner Door Liner

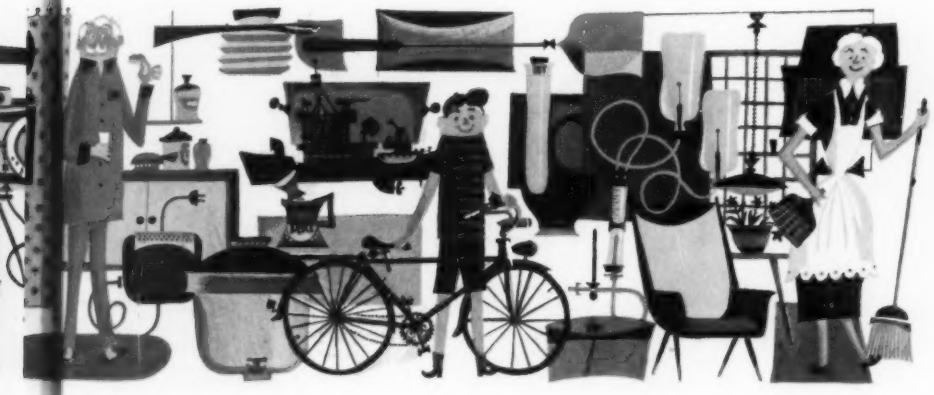


Food Packaging



Wall Tile

AUTOMOBILE PARTS • CAMERA CASES • BRISTLES • THIN GAUGE FILM • CONTAINERS • VIALS • HOUSEWARES • PLASTIC SHEETS • WALL TILE • WALL COVERINGS



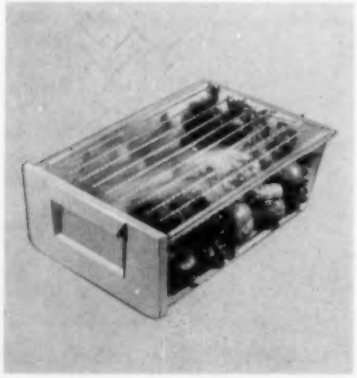
DOW®

NOZZLES • TUMBLERS • CLOSURES • OIL-FILTER AND GASOLINE PUMP BOWLS • MEDICAL EQUIPMENT COMPONENTS • RIGID FOOD CONTAINERS

Tableware



Refrigerator Crisper



Cartridge Filter Housing



Unique resistance to chemicals and moisture

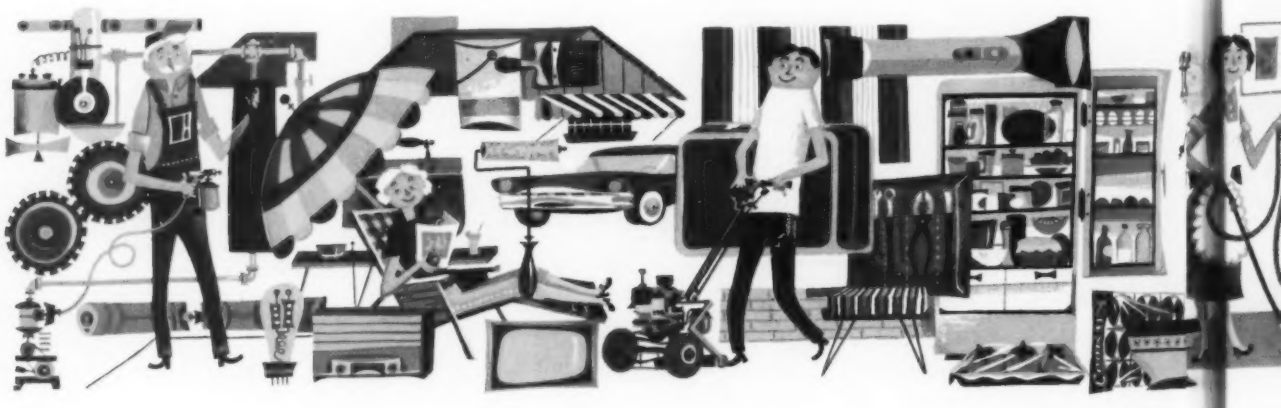
HIGH TENSILE STRENGTH • SELF-EXTINGUISHING • EXCELLENT CHEMICAL RESISTANCE • EASY TO CLEAN • EXCELLENT WEATHERING RESISTANCE • WILL NOT SUPPORT FUNGUS GROWTH • GOOD COLOR STABILITY

FOR TEXTILE FIBERS, EXTRUSION, INJECTION, COMPRESSION AND TRANSFER MOLDING, AND PACKAGING FILM—Because of an outstanding combination of properties, saran has become first choice among many users of plastics. In numerous cases, no other material meets service requirements as well as saran. It combines toughness, flexibility and durability with an amazing resistance to the abrasive and corrosive action of most chemicals. What's more, water absorption and vapor-transmission rate are extremely low. An outstanding food protector, an excellent lining for solution-carrying pipe, a superb fiber for outdoor fabrics—these only begin to indicate the unmatchable qualities of saran, one of the most inert of all thermoplastics. Let us tell you more.

SARAN

polymers and copolymers of vinylidene chloride plus similar materials

APPLICATIONS INCLUDE: PAINT GUN ATOMIZERS • RAYON SPINNER COUPLINGS • PIPE • FITTINGS • COUPLINGS • WINDOW SCREENING • AUTO SEAT COVERS AND UPHOLSTERY • AWNING



APPLICATIONS INCLUDE: ROLLER WHEELS FOR GARAGE DOORS • SELF-LUBRICATING GEARS • LUGGAGE END CAPS • LAWN MOWER ROLLERS • UNBREAKABLE FLASHLIG HOUSING

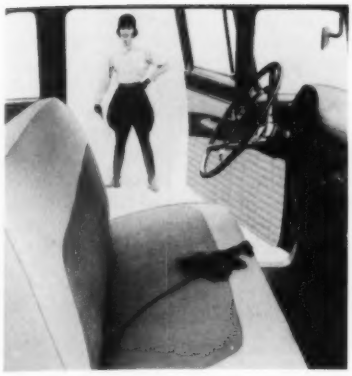
ETHOCEL®

an ethylcellulose molding compound

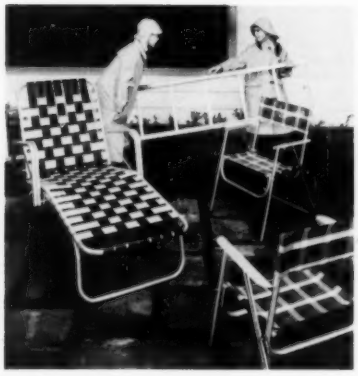
The aristocrat of thermoplastics

SELF LUBRICATING • LIGHT WEIGHT • RESISTANT TO MANY CHEMICALS • WITHSTANDS IMPACT OVER WIDE TEMPERATURE RANGE • LOW MOISTURE ABSORPTION • ODOR FREE • WIDE COLOR RANGE

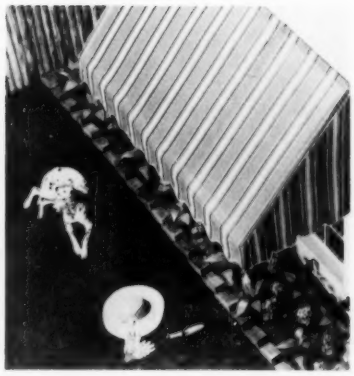
FOR INJECTION MOLDING AND EXTRUSION—If you're looking for the very best, you've found it in Ethocel. Only Ethocel offers such characteristics as toughness, light weight, chemical and impact resistance over a wide temperature range. Takes extreme shocks with ease. Self lubricating compounds ideal for oilless gear and bearing applications. Free from odor, too. A variety of formulations answer your general purpose requirements and special assignments that call for great strength, excellent dimensional stability, shock resistance. Flexibility found in property combinations like this is reason enough for considering Ethocel, the aristocrat of thermoplastics!



Automotive Seat Covers



Outdoor Furniture



Residential Awnings

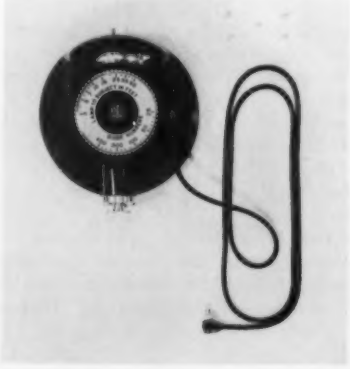
• AWNINGS • TAPES • WEBBING • RADIO-TV GRILLE CLOTHS • ACID RESISTANT FILTERING CLOTHS • DRAPERY • CARPETING • PACKAGING • FILM • DOLL HAIR • BRISTLES



DOW

HOUSINGS • VACUUM CLEANER PARTS • TOOL HANDLES • REFRIGERATOR BREAKER STRIPS • EXTRUDED TABLE EDGINGS • ROCKET COMPONENTS (MILITARY)

Photo-flash Reflector



Luggage End Caps



Freezer and Refrigerator Breaker Strips



Almost no limit to property possibilities

UNIFORM PROCESSING CHARACTERISTICS • UNIFORM MOLECULAR WEIGHT DISTRIBUTION • UNIFORM GRANULATION FOR FREE FLOW, CONSTANT FEED • CLARITY • HIGH FINISH • SUPERIOR STRESS CRACK RESISTANCE • SUPERIOR DROP IMPACT PROPERTIES • GOOD AGING CHARACTERISTICS

FOR INJECTION MOLDING, EXTRUSION, PAPER COATING—From a broad background of experience in manufacturing ethylene chemicals and plastics has come Dow polyethylene. Its complete uniformity makes possible more profitable processing, fewer rejects and greater economy in quality output. With our versatile plant processes, property combinations can be varied almost to infinity. To supplement the well-known low density materials, Dow also produces the intermediate density type materials. In addition, linear or high density polyethylenes are being thoroughly researched and evaluated. This intriguing polyethylene family will definitely gain importance in shaping tomorrow's better products. For the very latest in uses and methods, for the right polyethylene today, give Dow a call now.

POLYETHYLENE low density, inter

APPLICATIONS INCLUDE: FILM • WIRE AND CABLE COVERINGS • PAPER COATINGS • BOTTLES



APPLICATIONS INCLUDE: WIRE COVERINGS • FILM AND SHEETING • DRAPES • SHOWER CURTAINS • UPHOLSTERY • GARDEN HOSE • TUBIN

PVC RESINS polyvinyl chloride

For special and general-purpose requirements

VARIOUS GRANULATIONS • GREATER PLASTICIZER ABSORPTION • WIDER CHOICE OF PLASTICIZERS POSSIBLE • FREE FLOWING IN DRY BLEND PROCESSING • SHORTER BLENDING CYCLES • FASTER EXTRUSION RATES • HIGHEST UNIFORMITY • SUPERIOR CLEANLINESS

FOR EXTRUSION, WIRE COATING, CALENDERING, MOLDING—Dow PVC resins represent a dramatic advance to the trade, because they are versatile and easy to fabricate. General purpose and specialized requirements are met with four formulations in various granulations. Each of these compounds—PVC-100, PVC-111, PVC-133 and the newest addition, PVC-144—contributes to lower cost fabricating, more attractive products of greater durability and utility. Faster absorption of polymeric plasticizers and shorter blending cycles are only two of the profit-making advantages available to you. And improvements are forthcoming continually as Dow draws on resources and polymerization experience dating back to the infancy of the thermoplastics industry. Dow PVC resins—your answer for topping competition!



Clothes Basket



Film Packaging and Bags



Blown Bottles

intermediate density and high density materials

BOTTLES AND OTHER ENCLOSURES • HOUSEWARES • TOYS • PIPE



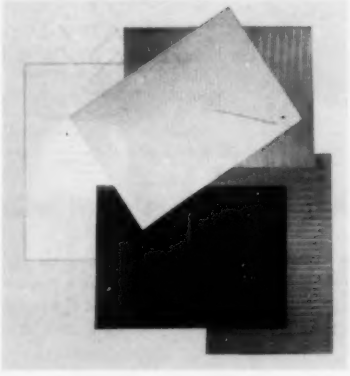
DOW®

• TUBING • GASKETS • GROMMETS • HOUSINGS • ENCLOSURES • INFLATABLE GOODS • MEDICAL TUBING • SHOE WELTINGS

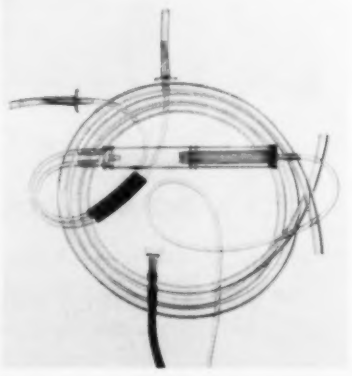
Garden Hose



Floor Runners



Medical Tubing

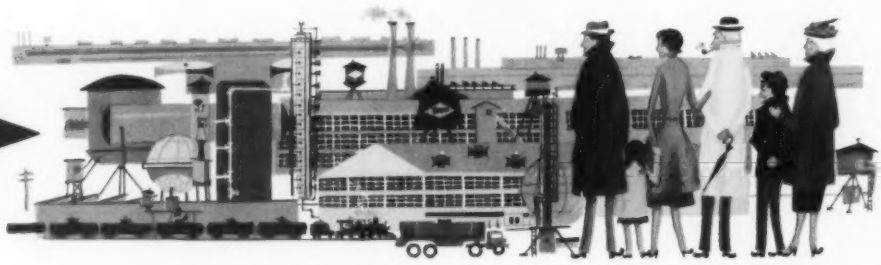


FROM EXPERIENCE AND YOUTH COME NEW IDEAS AND SOLUTIONS TO YOUR PLASTICS PROBLEMS

A pioneer in thermoplastics development, production and service, Dow today is a leader in this vital field. Technical service laboratories are maintained in Midland, Michigan; Freeport, Texas; Allyn's Point, Connecticut; and Torrance, California . . . where research scientists, technicians and engineers have helped shape the ever-expanding future for plastics.

Many of these dedicated men have grown with the industry from its beginning. (One Dow inventor holds more than 300 patents on plastics and related developments!) Their experience, plus the talents of production, styling, color and marketing service, combine to give you unequaled support in selecting, fabricating, forming and selling plastic products.

DOW®



Papers, technical bulletins and brochures covering every detail of plastics application, methods and equipment have been written and kept up to date. Any and all of this literature on Dow plastics is yours for the asking.

This service is backed by the industry's most complete facilities and is enhanced by a constant influx of new personnel. Each year, carefully selected college graduates join our plastics group, adding new vision, ideas and vitality.

To take advantage of our customer-service program—for more information on any member of America's First Family of Thermoplastics—contact us direct. Or write, wire or phone our nearest sales office.

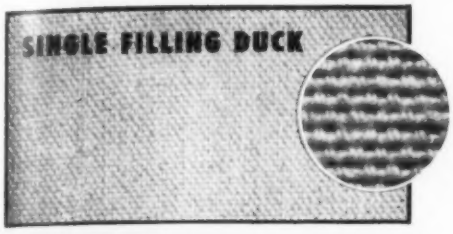
PLASTICS SALES DEPARTMENT

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

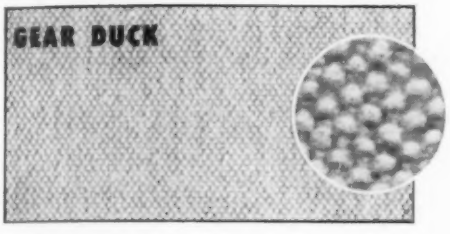
Atlanta • Boston • Buffalo • Camden • Chicago • Cincinnati • Cleveland • Detroit • Houston • Los Angeles • Minneapolis • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Dow Chemical of Canada, Limited, Toronto.

LITHO IN U.S.A.

Wellington Sears fabrics insure superior performance for high and low pressure LAMINATING



IMPACT STRENGTH... Wellington Sears single filling duck has the right weight and rugged, hard-gripping texture to make an excellent reinforcement for C grade laminates where high impact strength is important, as in the case of certain gears, safety helmets and mechanical parts of many kinds. Available in widths of 29 inches and wider and in weights from about 8 to 15 ounces per square yard.

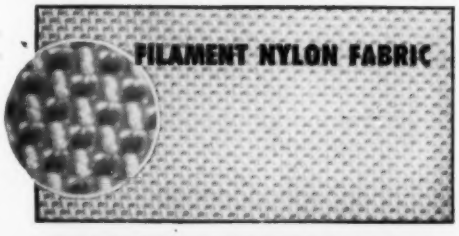


SHOCK RESISTANCE... Wellington Sears gear duck, like our Superior army duck, is a heavy, rugged fabric, ideal for shock-resistant laminates such as heavy duty mechanical parts in mechanisms subject to sudden starts and stops. Its plied yarn construction contributes high fiber density and freedom from sizing substances that sometimes hinder impregnation. Available in widths of 28½ inches and wider and in weights from about 8 to 15 ounces per square yard. Other Wellington Sears quality cotton fabrics for laminating include drills, Columbus sheeting, single and plied yarn chafers, and numerous special constructions.

GOOD INSULATOR... The nylon staple fibers in this fabric contribute high bonding strength and provide laminates with superior insulation resistance under high humidity conditions, a factor of special importance in items for the electronic and high frequency fields. Wellington Sears staple fiber nylon fabrics are made 28 to 72 inches wide in weights of about 4 ounces per square yard and higher. Also available to laminators are Wellington Sears fabrics of Orlon*, Dacron** and other synthetic fibers.



BALLISTIC PROPERTIES... In this fabric the strength of nylon yarns in filament form provides outstanding impact resistance to low pressure laminates such as wing board liners for military aircraft. Wellington Sears filament nylon fabrics are made in weights of about 2 ounces per square yard and higher, in widths from 28 to 72 inches. They are available in the grey or scoured and heat set for dimensional stability.



MULTI-DIRECTIONAL STRENGTH... Originally designed specifically for high pressure laminating, Lantuck is a non-woven, resin-bonded fabric whose revolutionary feature of random fiber distribution gives laminates equal strength in all directions and exceptional machineability at high cutting speeds. New, improved Lantuck is recommended as an economical filler for fine gears, bobbin heads and other laminates requiring sharp projections or edges, mirror-like machined surfaces and superior mechanical strength. Lantuck for laminating is 38 to 40 inches wide, weighing about 4 ounces per square yard, of various fibers and bonding agents.



*DuPont's trademark for its acrylic fiber
**DuPont's trademark for its polyester fiber

Wellington Sears

First in Fabrics For Industry

Wellington Sears Co., 65 Worth Street, NewYork 13, N. Y.

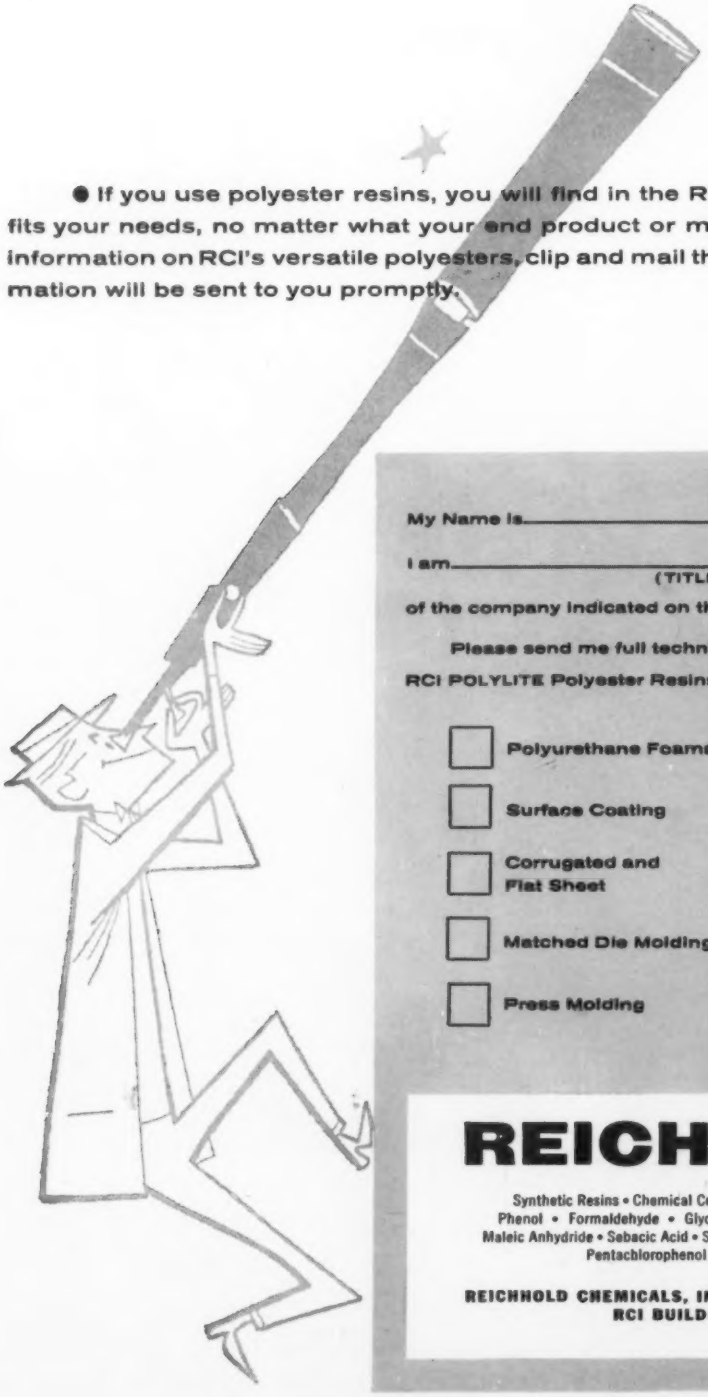
Offices in: ATLANTA • BOSTON • CHICAGO • DALLAS • DETROIT • LOS ANGELES • PHILADELPHIA • SAN FRANCISCO • ST. LOUIS

TAKE A CLOSE LOOK AT THE FULL LINE OF RCI

POLYLITE

POLYESTER RESINS

● If you use polyester resins, you will find in the RCI line a POLYLITE formulation that fits your needs, no matter what your end product or manufacturing procedure ● For full information on RCI's versatile polyesters, clip and mail the check list below. Technical information will be sent to you promptly.



My Name is_____

I am_____
(TITLE)

of the company indicated on this letterhead.

Please send me full technical information on the use of RCI POLYLITE Polyester Resins for:

- ☐ Polyurethane Foams
- ☐ Laminating
- ☐ Surface Coating
- ☐ Casting
- ☐ Corrugated and Flat Sheet
- ☐ Structural Lay-up
- ☐ Matched Die Molding
- ☐ Impregnating
- ☐ Press Molding
- ☐ Encapsulating

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives
Phenol • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Sodium Sulfite • Pentaerythritol
Pentachlorophenol • Sulfuric Acid

REICHHOLD CHEMICALS, INC.,
RCI BUILDING, WHITE PLAINS, N. Y.

Creative Chemistry... Your Partner In Progress

RCI

Guide to industry's most diversified line of plasticizers . . . from Monsanto

The following tables of properties and plasticizers were selected to guide you in making good use of industry's most diversified line of plasticizers . . . from Monsanto. Let's look at compatibility first.

COMPATIBILITY WITH THESE PLASTIC MATERIALS

MONSANTO PLASTICIZERS	POLY-VINYL CHLORIDE	POLY-VINYL BUTYRAL	POLY-VINYL ACETATE	NITRO-CELLU-LOSE	CELLU-LOSE ACETATE	ETHYL CELLU-LOSE	PHENOLIC	ACRYLIC TYPE	ALKYD	POLY-STYRENE	CHLORIN-ATED RUBBER	NITRILE RUBBER
PHTHALATES												
Dibutyl	C	C	C	C	LC	C	LC	C	C	C	C	C
Diethyl			C	C	C	C	LC	C	LC	C		
Dimethyl			C	C	C	C	LC	C	LC	C		
Diphenyl	SC		LC	C		LC	LC			LC		
Dicyclohexyl	SC		LC	C		LC		LC				C
Dioctyl (DOP)	C	C	SC	C		C						C
Di-isoctyl (DIOP)	C	C	SC	C		C						
Di-isodecyl (DIDP)	C	C	SC	LC		C						
Santicizer* 160	C	C	C	C		C	LC	C		C		C
Santicizer 213	C	C	C	C		C						
Santicizer 214	C	C	SC	SC		C						
Santicizer 602	C	C	SC	C		C						C
Santicizer 603	C	C	SC	C		C						C
Santicizer 606	C	C	SC	SC		C						C
Santicizer 611	C	C	SC	LC		C						C
Santicizer 613	C	C	SC	LC		C						C
PHOSPHATES												
Tricresyl	C	C	C	C		C	LC		C		C	C
Triphenyl	SC		LC	C	LC	SC						
Santicizer 140	C	C	C	C	LC	C	LC		C			C
Santicizer 141	C	C	C	C	SC	C		C				C
ADIPATES												
Dioctyl (DOA)	LC	C										
Di-isodecyl (DIDA)	LC	C										
GLYCOLATES												
Santicizer E-15	C	C	C	C	C	C	LC		C	LC	C	C
Santicizer B-16	C	C	C	C	LC	C	LC	C	C	LC		C
Santicizer M-17	LC	C	C	C	C	C	LC	C	C		C	
SULFONAMIDES												
Santicizer 1-H			SC	C	SC	LC			SC			
Santicizer 3					LC							
Santicizer 8		C	C	C	C	LC	LC					C
Santicizer 9					LC		LC			SC		
Santolite* MS 80%			C	C								
Santolite MHP	SC		C	C								
CHLORINATED POLYPHENYLS												
Aroclor*	LC		C	C		C					C	C
SPECIALTIES												
HB-40*	LC	LC	SC	SC		C				C		
HB-20*	SC		SC			LC						
Montar*	SC											

C—(Compatibility)—25-100 pts. per 100 parts resin. LC—(Limited Compatibility)—10-50 pts. per 100 parts resin. SC—(Slight Compatibility)—1-25 pts. per 100 parts resin.

*Reg. U.S. Pat. Off.

No matter what plastic or plastic-like material you work with, when you depend on Monsanto you can always choose a compatible plasticizer system . . . avoid incompatibility and undesirable plasticizer exudation. You get wide compounding latitude, too, when you work with Monsanto plasticizers. That's because of the many excellent combinations available for virtually every need.

Such convenient variety from one source is possible because Monsanto is America's most diversified supplier of plasticizers . . . originator of that industry standard, DOP . . . only source of chlorinated polyphenyls . . . producer of more than 50 different individual plasticizers in more than 7 basic chemical types. Nowhere else can you get such a choice selection of plasticizers for every practical purpose.



Monsanto

for optimum performance . . .

THESE TYPICAL PROPERTIES

MONSANTO PLASTICIZERS	TEAR AND TENSILE STRENGTH	SOFTNESS EFFICIENCY	LOW TEMPERATURE FLEXIBILITY	FLAME RESISTANCE	WATER RESISTANCE	LOW COST	ELECTRICAL RESISTANCE	NON-TOXICITY ‡	LOW VOLATILITY	GREASE AND SOLVENT RESISTANCE	LIGHT AND HEAT STABILITY
PHTHALATES											
Dibutyl	X	X	X		X						
Diethyl	X	X				X		E			E
Dimethyl	X	X				X					E
Diphenyl	E				X				X	X	E
Dicyclohexyl	X				X				X	X	E
Dioctyl (DOP)	X	E	X		X		E	X	X		E
Di-isooctyl (DIOP)	X	X	X		X		X	X	X		E
Di-isodecyl (DIDP)		X	X		E		E		E		E
Santicizer 160	E	E	X		X	X	X		X	E	E
Santicizer 213	X				X						E
Santicizer 214	X				X				X		E
Santicizer 602	X	X	X		X		X		X		E
Santicizer 603	X	X	X		X	X	X		X		E
Santicizer 606	X	X	X		X		X		X	X	E
Santicizer 611	X	X	X		X		X		X	X	E
Santicizer 613	E	X	X		X		X		X	X	E
PHOSPHATES											
Tricresyl	E	X		X	X		X		E	E	E*
Triphenyl	X			X	X				E	X	
Santicizer 140	E	X	X	X	X				E	E	E*
Santicizer 141	E	E	X	X	X			E	X	E	E*
ADIPATES											
Dioctyl (DOA)	X	E	E		X				X		E
Di-isodecyl (DIDA)	X	E	E		X				X		E
GLYCOLATES											
Santicizer E-15	X	X	X		X			E		X	X
Santicizer B-16	X	X	X		X			E		X	X
Santicizer M-17	X	X	X		X			X		E	X
SULFONAMIDES											
Santicizer 1-H	E								X	X	
Santicizer 3	E								X	X	
Santicizer 8	X	X	X						X	X	
Santicizer 9	E								E	X	
Santolite MHP										X	
Santolite MS 82%										X	
CHLORINATED POLYPHENYLS											
Aroclor	X			X		X	X			E	
SPECIALTIES											
HB-40	X					X	X				
HB-20	X					X	X				
Mentor				X		X				X	

KEY: [illegible]ellent X—Denotes Value ‡(E—Edible Approval E—Approved for limited use only) E*—Excellent light stability, but requires special stabilization for heat exposure

Plasticizers

. . . in every plastic application

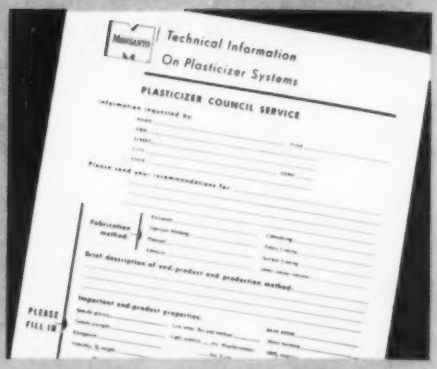
THESE TYPICAL APPLICATIONS

MONSANTO PLASTICIZERS	FILM AND SHEETING	FLOORING	ELECTRICAL APPLICATIONS	NON-TOXIC APPLICATIONS	EXTRUDED GOODS	PLASTISOLS	MOLDED GOODS	FABRIC COATING	METAL COATING	LACQUERS	ADHESIVES	FOAMS
PHTHALATES												
Dibutyl	R						R	RC	R	R	R	
Diethyl	RC			R			RC			R	R	
Dimethyl	RC						RC			R	R	
Diphenyl										R	R	
Dicyclohexyl										R	R	
Dioctyl (DOP)	R	R	R		R	R	R	R	R	R	R	
Di-isooctyl (DIOP)	R	R	R		R	R	R	R	R	R	R	
Di-isodecyl (DIDP)	R	R	R		R	R	R	R	R			
Santicizer 160	R	R	R		R	R	R	R	R	R	R	R
Santicizer 213	RC				RC	RC	RC	RC	RC	RC		RC
Santicizer 214	RC				RC	RC	RC	RC	RC	RC		RC
Santicizer 002	R	R	R		R	R	R	R	R			
Santicizer 003	R	RC	R		R	R	R	R	R	RC	R	
Santicizer 008	R	R			R		R	R	R			
Santicizer 011	R	R			R		R	R	R			
Santicizer 013	R	R			R		R	R	R			
PHOSPHATES												
Trioctyl	R	R	R		R	R	R	R	R	R	R	R
Triphenyl	RC						R			R	R	
Santicizer 148	R	R			R	R	R	R	R	R	R	R
Santicizer 141	R	R		R	R	R	R	R	R	R	R	R
ADIPATES												
Dioctyl (DOA)	RC	RC	RC		RC	RC	RC	RC	RC			
Di-isodecyl (DIDA)	RC	RC	RC		RC	RC	RC	RC	RC			RC
GLYCOLATES												
Santicizer E-15	R			R						R	R	
Santicizer B-16	R			R	R	R	R			R	R	
Santicizer M-17	R			R	R					R	R	
SULFONAMIDES												
Santicizer 1-H							R			R	R	
Santicizer 3							R			R	R	
Santicizer 8					R		R			R	R	
Santicizer 9							R			R	R	
Santolite MHP										R	R	
Santolite MS 80%										R	R	
CHLORINATED POLYPHENYLS												
Aroclor	R		R		R	R	R		R	R	R	
SPECIALTIES												
HB-40	RC		R		R	R	R	R	R	R	R	
HB-20			R		R	R	R				R	
Mesitar											R	

R—Recommended as satisfactory RC—Recommended in combination with other plasticizers

Monsanto Plasticizer Services

Monsanto has the plasticizers for you. But more than that, for your specific questions and compounding problems Monsanto maintains a Plasticizer Council Service for technical group guidance. To put this select team of technical people to work for you, ask your local Monsanto representative to help you fill out a "Plasticizer Council" request card. Quickly you'll receive qualified solutions to situations such as these and many others:



Calendered Vinyls

Need higher gloss in flooring? Monsanto Plasticizer Council recommend you try one of these three plasticizers—Santicizer 140, Santicizer 160 and Monsanto TCP—to improve gloss. Your floor tile will collect less dirt, clean easier, need less waxing to have more consumer appeal.

Other typical problems for which they can provide answers are how to

- *improve light stability of vinyl film*
- *impart flame resistance to sheeting*
- *lend film better hand*
- *give more permanent flexibility*

Vinyl Extrusions

Looking for nontoxic blown film formulations? Monsanto Plasticizer Council recommend Santicizer 141 as one ingredient. It not only meets BAI and FDA specifications but also speeds up blending, improves clarity and gloss through faster, more thorough solvating action.

Monsanto also has suggestions for

- *lowering compound costs*
- *resisting hydrolysis in electrical wire insulation*
- *obtaining faster, smoother dry blends*
- *achieving greater water resistance*

Vinyl Dispersions & Solutions

Want longer shelf life for plastisols? Monsanto Plasticizer Council recommend DIDA and DIDP as specialty plasticizers to retard thickening and prevent gelling at room temperatures. DIDA offers low-temperature flex properties as well.

Can we help you get

- *faster fusion in slush molding?*
- *diminished dilatancy for coating fabrics?*
- *increased abrasion resistance?*
- *better cell structure in foams?*

Other Plastics

Injection molding nylon? Monsanto Plasticizer Council suggest Santicizer 8 to extend polyamides, reduce raw-material costs. It also increases flexibility and toughness, and lowers the melting point to cut molding costs.

Perhaps your question is similar to one of these: "How can I get

- *higher dimensional stability in my acetate sheet?"*
- *lower cost in ethyl cellulose hot melts?"*
- *more uniform dispersion of fillers in phenolics?"*
- *special properties for my nitrocellulose coatings?"*

Whatever your problem in plasticizing, Monsanto will be happy to help you solve it, whether it concerns processing ease and speed, physical properties of the end product, or cost reductions. In addition to expert technical assistance and a wide selection of top-quality plasticizers for every need, you get one-stop service, mixed bulk shipment at bulk prices, and prompt delivery. If we may be of service to you in any way, just fill in the coupon or write.

Monsanto Chemical Company
***Organic Chemicals Division*, Dept. ENC**
St. Louis 1, Missouri

Please have a salesman call about Plasticizer Council Service.

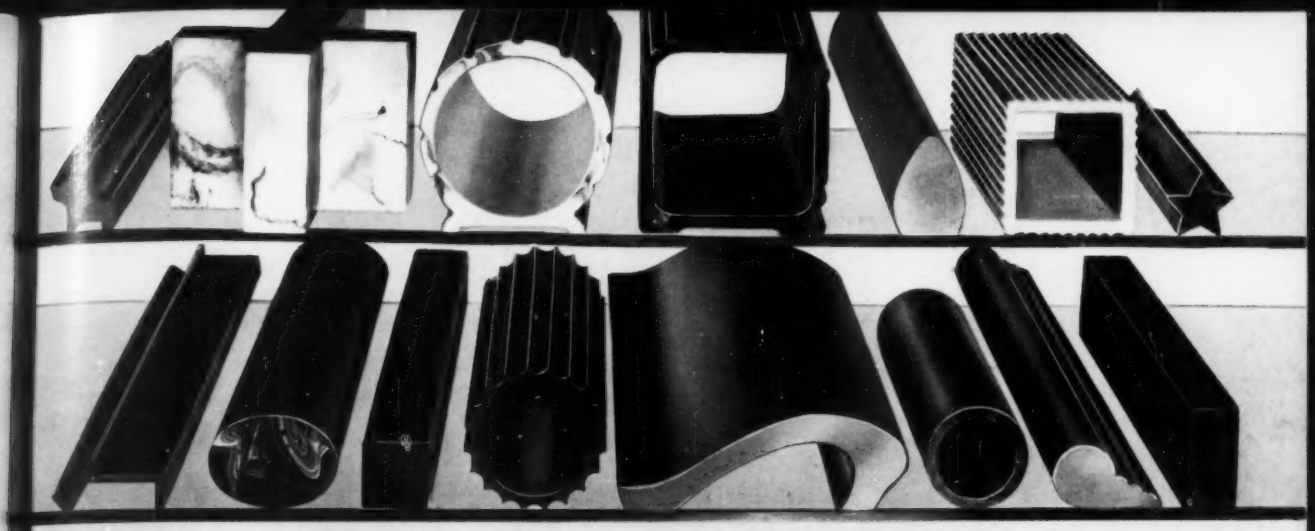
Name.....

Title.....

Company.....

Address.....

Monsanto



Marblette Cast Phenolic Resins

Marblette is a pure, synthetic resin, unlike molding powders which are mixed with large amounts of fillers.

Marblette is sold in sheets, rods, tubes and special shapes in forms and colors designated below.

Jewel-like depth and complete color range enable Marblette to duplicate the appearance of such precious stones as amber, jade, coral, etc., as well as tortoise shell and ivory.

Marblette can be had in transparent, translucent and opaque forms in an infinite variety of plain colors and mottled effects.

Marblette can be supplied in water-clear form known as "Crystle" which is also made in a wide range of colors and shades.

PROPERTIES

Specific Gravity	1.30-1.32
Specific Volume, cubic inch per lb.	20-23
Tensile Strength, lbs. per sq. inch	8000-12000
Compressive Strength, lbs. per sq. inch	15000-30000
Impact Strength, ft. lbs. per inch of notch (Izod Test)	0.40-0.50
Modulus of Elasticity, lbs. per sq. inch x 10^5	4
Thermal Conductivity 10^4 cal., per second, per square cm/1° C. per cm	3-5
Thermal Expansion 10^5 per degree C.	8-11
Specific heat, cal. per degree C. per gram.	0.3-0.4
Heat resistance, °F.	170°
Water absorption, % by weight, 48 hours	0.4-0.6
Volume resistivity, ohm-cms (50% relative humidity and 25° C.)	10^{12}-10^{13}
Breakdown Voltage, 60 cycles, volts per mil. (instantaneous)	300-450
Dielectric constant, 10^6 cycles	5-7
Power Factor, radio frequencies	1-4.5
Power Factor, 60 cycles	0.10-0.15
Refractive Index Nd	1.5-1.7
Burning Rate	Nil
Effect of Weak Acids	No effect
Effect of Strong Acids	None to slight effect
Effect of Strong Alkalies	Decomposes
Effect of Ageing	Hardens & Yellows
Effect on Metal Inserts	None
Machining Qualities	Excellent
Clarity	Waterclear, Opaque, Translucent
Color Possibilities	Unlimited

MACHINING CHARACTERISTICS

Drilling: High speed vertical drill.

Tapping: On vertical or horizontal machines.

Turning: 450 to 600 RPM regulated to surface speed of 600'/minute. No special tool materials necessary.

Stamping: Roll leaf method usually used.

Cutting: Use abrasion cut-off wheels with water; polish by hand or tumbling.

Polishing: Use double spindle buffing lathe with soft muslin discs.

Grinding: Abrasive form wheels for bevels, radii, other finishing touches not usually included in rough castings.

Sawing: Band saw at 1200' to 1500'/minute using blower and changing saws frequently to cool.

Tumbling: Wet tumbling for very rough articles; dry tumbling is equivalent to ashing and most frequently used; grease or wax tumbling produces high lustre.

SHAPES AVAILABLE FROM STOCK MOLDS

Rods: Round, fluted, square, four-leaf clover, scalloped, eight-corner "square", three-leaf clover, oval, three point, octagonal, half round, quarter round, hexagonal.

Rectangular shapes • Sheets and slabs
Cylinders • Sheets between glass

—All in wide range of sizes, lengths and/or diameters.

Many open special shapes are also available, such as: cutlery handles, kitchen utensils handles, pipe stems, clock cases, automotive trimmings, furniture trims, lamp parts, jewelry items, buttons, many others.

SPECIAL CASTINGS MADE TO CUSTOMERS' SPECIFICATIONS

If you desire castings which are not available from stock molds, special shapes can be made to your specifications, providing draft is all one way. Such special molds can be designed and produced quickly—within three weeks—and at a cost far less than for any other type mold.

ENGINEERING SERVICE

For further detailed information covering any of the above, consult the Marblette engineering staff which offers its services and counsel to help solve your problems. Years of extensive experience with all types of production problems have qualified them to assist you.

PHENOLIC

Since 1929—liquid and cast phenolic resins—epoxy resins

The Marblette Corporation

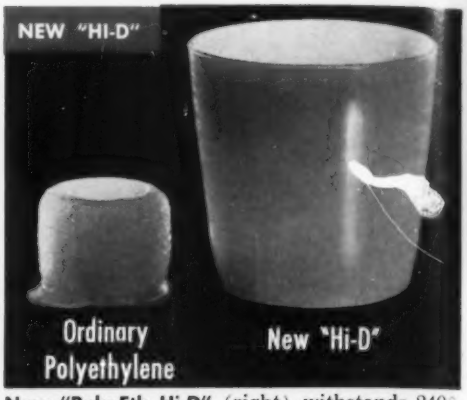
37-00 Thirtieth Street, Long Island City 1, N. Y.

CHICAGO • DETROIT • LOS ANGELES
MONTREAL • WICHITA • HAVANA

Which of These "Poly-Eth" Resins Can Solve Your Problems Best?



Proven in countless applications, Spencer "Poly-Eth" molding resins are available in standard or custom-made grades. See us for a resin to fit your specific molding needs.



New "Poly-Eth Hi-D" (right) withstands 240° heat. Has density of .935. Ready in commercial quantities for film, molding, other uses.



New glass-clear "Poly-Eth" resins make film that's twice as clear as conventional polyethylene. Has higher gloss, is stiffer and easier to handle. Tailored to your own needs in both blown and flat film.

No matter what your needs, it will pay you to investigate Spencer "Poly-Eth" resins. Spencer has a full range of polyethylene resins with a variety of densities and properties.

Not only that, but Spencer's fast delivery and expert Technical Service can help you eliminate your raw material problems. For full information, contact the Spencer office nearest you.

Poly-Eth® Polyethylene

by

SPENCER®

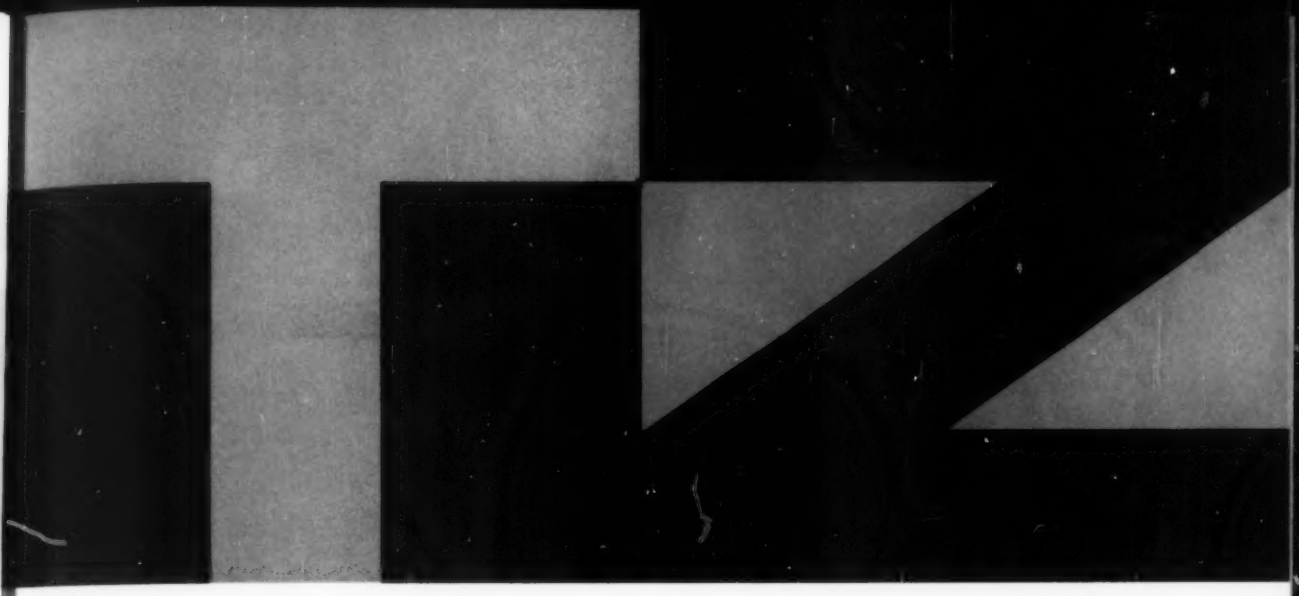


SPENCER CHEMICAL COMPANY

GENERAL OFFICES: Dwight Bldg., Kansas City 5, Mo.

DISTRICT OFFICES: Dwight Bldg., Kansas City 5, Mo. (BAltimore 1-6600).
500 Fifth Ave., New York City (LAckawana 4-7762).
First National Bank Bldg., Chicago (ANdover 3-2656).
1435 S La Cienga, Los Angeles (OLeander 5-7626).

WAREHOUSES: New York City
Chicago
Los Angeles
Orange, Texas

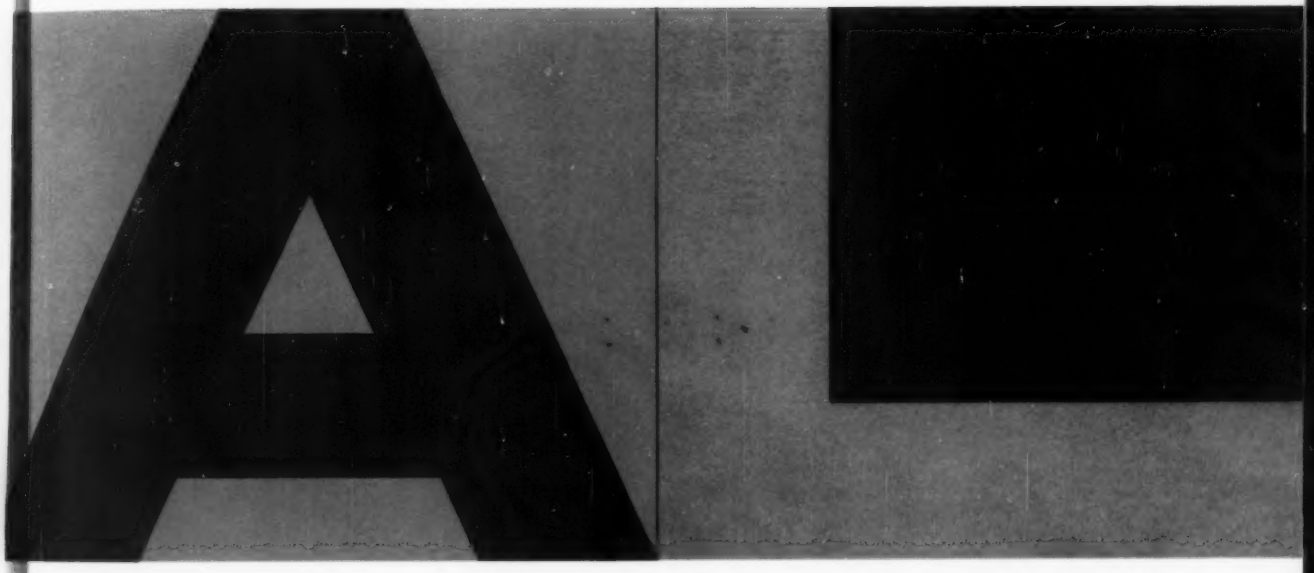


TEFLON®

FLUOROCARBON RESINS

ZYTEL®

NYLON RESINS



ALATHON®

POLYETHYLENE RESINS

LUCITE®

ACRYLIC RESINS

The purpose of this brochure is to provide data which will aid designers and engineers in evaluating and specifying TEFLON fluorocarbon resins, ZYTEL nylon resins, ALATHON polyethylene resins, and LUCITE acrylic resins—versatile plastic engineering materials made by Du Pont.

For information beyond the scope of this brochure, the experience of Du Pont's staff of technical specialists is available to users and prospective users of these materials.

TEFLON • 2,3,4,5
ZYTEL • 6,7,8,9
ALATHON • 10,11,12
LUCITE • 13,14,15
SALES SERVICE LAB and DISTRICT OFFICES • 16
PRODUCT DATA • 16,17,18,19
POSTAL CARD FOR MORE INFORMATION • 18
SPIN WELDING • 20

DU PONT

DU PONT

TEFLON®

FLUOROCARBON RESINS

application:

Extreme chemical inertness, resiliency and toughness are the properties of TEFLON resins that make them especially suited for such applications as the pump bearing parts shown below. When these submersible pumps are used for pumping certain chemicals, TEFLON resins are the only materials that will resist corrosion and give long, efficient service. This assembly is one of the many crucial components that can be made from TEFLON resins for the handling of corrosive liquids. Other related items include gaskets, packings, valve seats, discs and specially fabricated components of pumps, agitators and mixers.

The high dielectric strength and low heat conductivity of TEFLON fluorocarbon resins make them superior insulation in high frequency circuits, particularly where miniaturization is required. Wire insulated with a TEFLON resin may be of smaller gauge than wire for the same load that is insulated with other materials. Area insulation in electronic equipment may be thinner and lighter due to the ability of TEFLON resins to withstand heat and prevent current leakage.

Bearing assembly of TEFLON tetrafluoroethylene resins in submersible pump resists chemical attack and needs no lubrication.





DAN-

TEFLON® ZYTEL® ALATHON® LUCITE®

write for additional data


TEFLON® ZYTEL® ALATHON® LUCITE®
write for additional data

description:

TEFLON is the Du Pont registered trademark for fluorocarbon resins, engineering materials that are unique in their ability to resist chemical corrosion, to provide heat and electrical barriers of maximum efficiency, to resist penetration by or absorption of water, to resist adhesion, and to minimize friction.

TEFLON fluorocarbon resins are supplied in three forms: in molding powders, extrusion powders which are compounded with an organic extrusion aid, and in aqueous dispersions. The general purpose molding powders are granular powders of about a 30 mesh size.

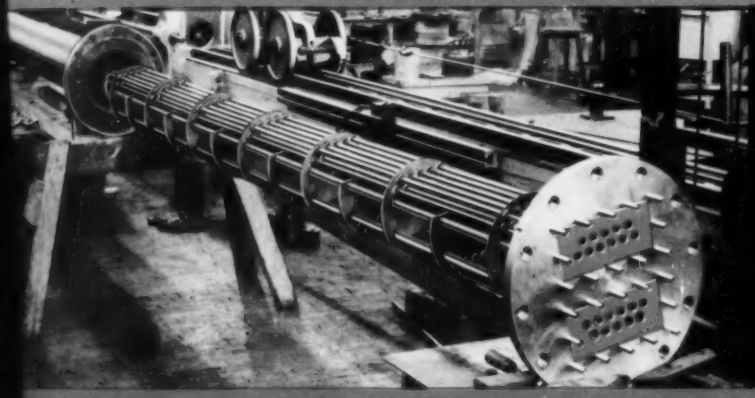
When fabricated into tape, sheets, rods, cylinders, wire and fabric coatings, laminates or various parts, the material has a waxy appearance, and has the same slippery feel. Surfaces of TEFLON resins are so anti-stick that TEFLON resins are used to coat bakery rollers and other food equipment to prevent sticking and eliminate greasing of utensils.

Coatings formed on surfaces by applications of the enamels based on TEFLON resins provide the same surface properties as are available in massive fabricated forms.

properties:

TEFLON fluorocarbon resins are inert to nearly all chemicals and solvents normally used in commercial practices. An exception to this is metallic sodium and the other alkali metals. At elevated temperatures and pressures, halogens and certain halogenated chemicals and solvents may affect TEFLON resins.

Thermally, TEFLON tetrafluoroethylene resins are exceptionally stable, and may be used efficiently in applications that must withstand temperatures as low as —450°F. or as high as 500°F. The combina-



Grommets and gaskets of TEFLON resins support the tubes in this heat exchanger, which raises the temperature of strong nitric acid to 350°—375°F. Parts also prevent galvanic action which could destroy the tantalum tubes.



Packings of TEFLON resins provide uniform performance and long service life. They are impervious to liquids and gases. The low coefficient of friction of TEFLON resins not only reduces torque, but also increases mechanical efficiency.



Envelope gaskets of TEFLON tetrafluoroethylene resins consist of a soft filler covered by a jacket of TEFLON. They are used for sealing large diameters and where bolting pressures must be limited, as in glass-lined equipment and in pipe made from ceramic materials.

tion of this unusually broad temperature range with a low loss factor and a high dielectric strength makes TEFLON resins unique for high frequency insulation.

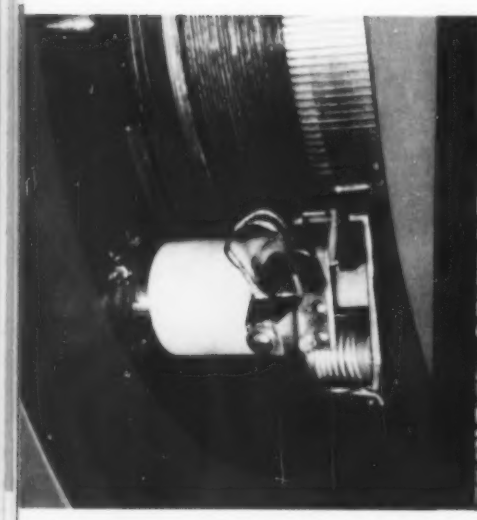
The waxy texture of TEFLON provides a surface so non-adhesive that even the stickiest and most viscous materials will not adhere permanently to it. The friction between two surfaces of TEFLON is as low as that of ice rubbing on ice. Kinetic coefficients of friction as low as .04 have been measured between surfaces of TEFLON. A useful trait of TEFLON resins is their tendency to deposit a molecular film on other materials rubbed against them. A very thin film of a TEFLON resin is thus developed on the opposing surface, and the resulting bearing of TEFLON on TEFLON is virtually frictionless.

TEFLON resins alone may be used as bearing materials in applications where bearing loads are low. Higher load bearing capacity may be achieved by reinforcement with other materials.

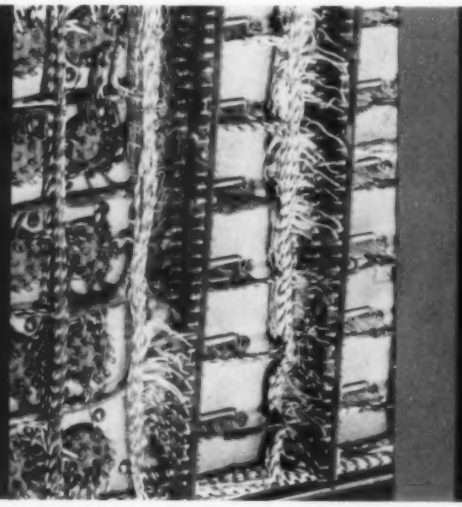
In addition to these dominant qualities, TEFLON resins are exceedingly tough, completely unaffected by outdoor weathering, have good impact strength over the entire temperature range, and are relatively flexible.

forming and working:

Because TEFLON resins do not melt and flow, molding techniques used on them must be different from those used on the more common resins. TEFLON resins are formed by a modification of compression molding techniques in which the material is first cold formed, and then sintered at high temperatures. Extrusion techniques have been developed in which the forming of rods, bars and tubes and the sintering



TEFLON resins have been found the ideal materials for use in the brushholder sleeves for this motor-generator, which is used in high-speed freight train service, because of their high short-time dielectric strength.



Wire coated with TEFLON 6 provides outstanding service in electronic units and components such as this amplifier and computer for automatic pilot and automatic flight control system.



Lead-through bushings and connectors of a TEFLON resin have excellent corona, arc and ohmic resistance, maintaining their seal when cycled repeatedly over a wide range of temperatures.

of them are accomplished as consecutive stages in the same operation. In the formation of large sheets of TEFLON, billets and certain special shapes, the powder is formed in one operation, and sintered in a second operation. Thin sections of TEFLON may be made by a new process in which a lubricated paste of a TEFLON resin is extruded. Tape and coated wire may be produced by calendering. Tape may also be made by skiving sheet from cylinders and then slitting it.

Complex shapes may be produced by machining rod and tube stock. Where desirable, TEFLON resins may be colored by the addition of pigment to the powders before they are formed. A variety of pigments is available to provide colors and shades. An ample range of colors may be obtained to accommodate color coding systems on wire for electrical and electronic circuits.



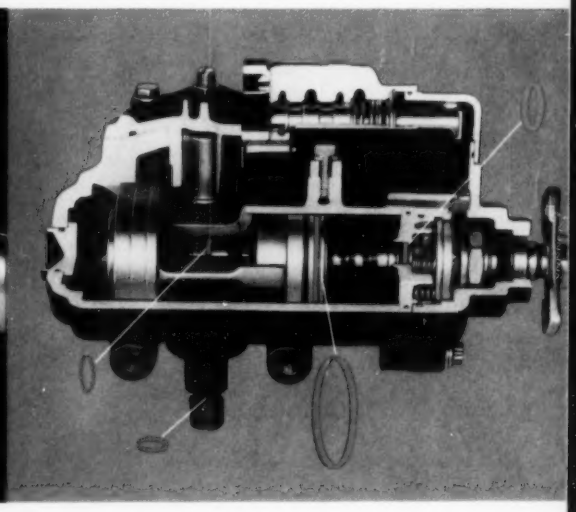
A hose assembly lined with a TEFLON resin transmits 80-octane fuel to the engine of this 1-man helicopter. The hose withstands subzero temperatures and tropical heat and humidity, and is unaffected by torsion and vibration.



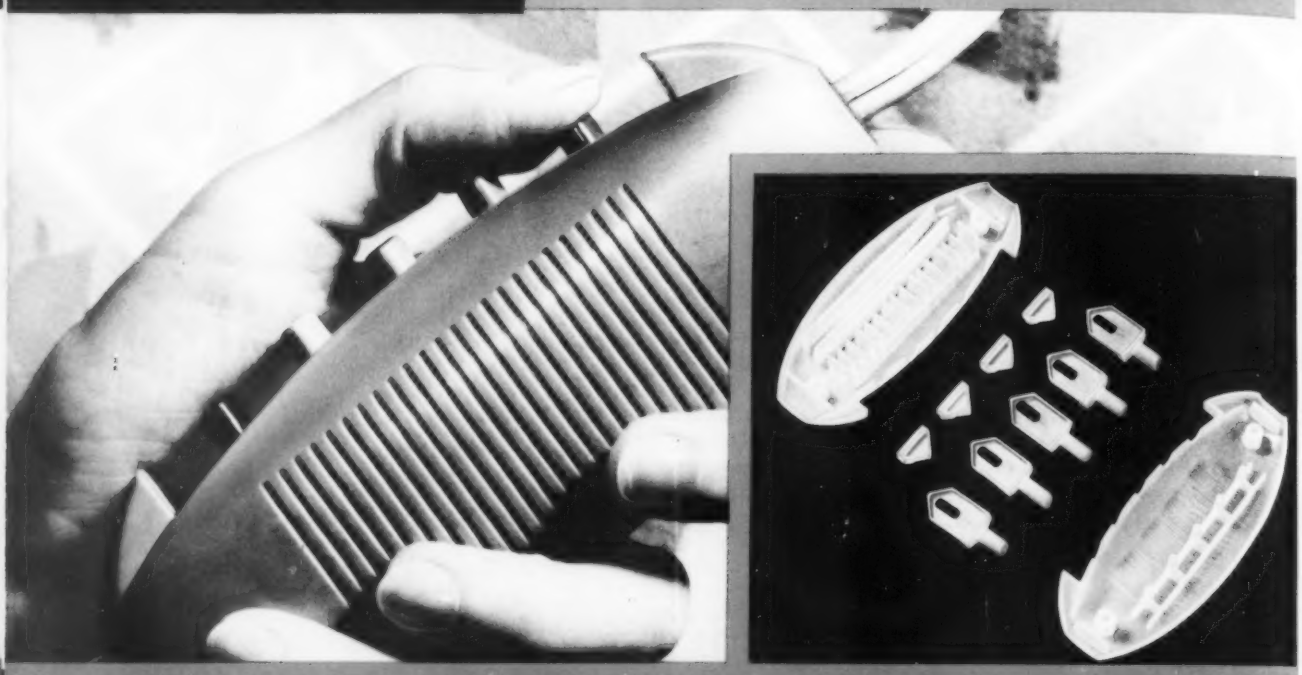
Water meter pistons of TEFLON tetrafluoroethylene resins assure accurate meter readings. The low coefficient of friction allows parts to move freely.



New heat and acid-resistant seals of a TEFLON resin check high pressures in drill pipe joints. Ring seals made of TEFLON tetrafluoroethylene resins prevent leakage at pipe joints.



Piston ring, seals and lockwasher of a TEFLON resin reduce manual turning effort and wear in this power steering mechanism. A TEFLON resin was selected because of toughness, low coefficient of friction, and thermal stability.



Heating pad switch of tough, resilient ZYTEL has simple, attractive exterior, intricately molded interior.

application:

Extraordinary mechanical strength, high surface hardness, ease of forming and low coefficient of friction, all major qualities of ZYTEL make this nylon resin a highly efficient material for such applications as guide shoes for elevator cars. Parts made of ZYTEL need little or no lubrication. Mass production is economical, and long and satisfactory service life is the rule.

When unlubricated gears of resilient ZYTEL are used, they are not subjected to the abrasion from hard particles which often collect in lubricants used with steel drives. ZYTEL is an effective material for making cams, shafts, worm gears, mechanical linkages, couplings and conveyor chains. Unlubricated in many of these applications, the resin is also highly resistant to solvents and chemicals. Components of ZYTEL operate efficiently at temperatures up to 250°F.

The dielectric strength of ZYTEL nylon resin adapts it to use in such applications as injection molded coil forms for electrical equipment that operates at commercial frequencies.

description:

ZYTEL is the Du Pont registered trademark for a versatile group of durable polymeric amides, noted for extreme toughness and strength.

Numerous formulations of ZYTEL nylon resins are available. All types of ZYTEL are supplied by Du Pont as molding powders; all compositions of ZYTEL are thermoplastic. The most common method of fabricating parts of ZYTEL in mass production is by the use of injection-molding equipment.

Rod and stock forms of ZYTEL are readily available from processors; from these forms parts may be machined or otherwise fabricated in the conventional manner. ZYTEL 42, a newly developed member of the family, has a viscosity especially tailored for extrusion. Some of the compositions of ZYTEL are available in a variety of colors. Parts of ZYTEL nylon resin may also be colored by immersing the parts in a boiling solution of dyes, such as those used for dyeing of household fabrics.

Of interest also is weather-resistant, black ZYTEL 105 especially developed for outdoor use.

properties:

ZYTEL is superior to conventional thermoplastics in that it does not show such pronounced decreases in tensile strength or increases in plastic flow at temperatures that approach its molding temperature. High temperature nylons are crystalline and have sharp melting points above which they are as fluid as a light lubricating oil. ZYTEL has a high impact strength, and excellent flexibility at temperatures as low as —40°F. High temperature operations should be held below 250°F. for continuous service. Electrically, ZYTEL is suitable for all insulation applications at commercial power frequencies, especially in instances in which mechanical strength and toughness are needed in addition to insulation properties.

ZYTEL is highly effective in cam and gear applications because it is resilient, abrasion resistant, strong, and has a low coefficient of friction. Where stresses are concentrated on small areas of gears made of ZYTEL, the resiliency of the resin permits a temporary deformation that distributes the load over a larger area. When the load is removed, the gear recovers its original form. In most gear applications, ZYTEL can be used without lubrication.

When lubrication must be used, a variety of lubricants other than oil and grease may be employed



ZYTEL nylon resin makes possible durable, non-shattering, colorful new designs for aerosol containers. A newly developed grade, ZYTEL 42, and a new fabricating technique are responsible for the entrance of ZYTEL into the aerosol field.

effectively. Many fluids have been found suitable lubricants for ZYTEL, for processes where greases could not be tolerated.

In mechanical applications, ZYTEL damps noise and vibration. ZYTEL is resistant to solvents, being insoluble in common solvents, alkalies, dilute mineral acids and most organic acids. Resistance to alkalies is outstanding.

All formulations of ZYTEL are soluble in phenols and formic acid, and are attacked by concentrated solutions of the mineral acids, but all of the forms are impervious to petroleum oils and greases, lactic acid, and photographic solutions.

forming and working:

ZYTEL nylon resins may be extruded or injection molded either as solid parts or around metal inserts.

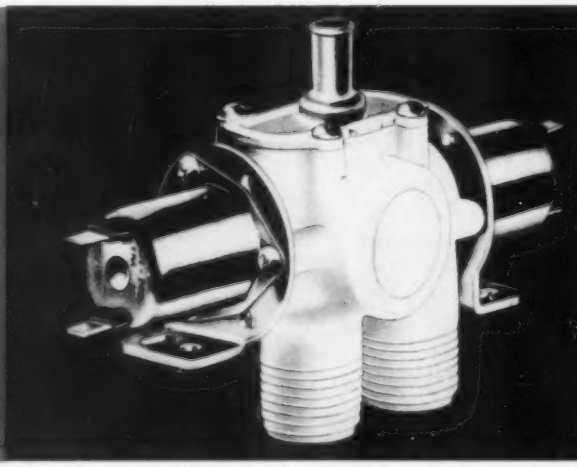
Where ZYTEL is molded to close tolerances that are essential in the finished part—particularly if the finished part has a thin section—the molding process may produce stresses in the resin which should be relieved, to assure long service life and to prevent distortion.

ZYTEL can be applied as jacketing or insulation to wires either directly or over other primary insulating materials.

Stock shapes of ZYTEL can be machined very easily with cutting tools of high speed steel, ground to produce minimum drag. Because ZYTEL is quite tough, cutting tools must be kept sharp, and vibration of the machinery is to be avoided. Where dimensional stability is essential, machined parts should be stress-relieved. The spin-welding technique is also useful for fabrication of ZYTEL nylon resins.



Du Pont ZYTEL nylon resin makes possible attractive, consumer products. This 7-transistor portable radio, for instance, has a virtually unbreakable case of ZYTEL.



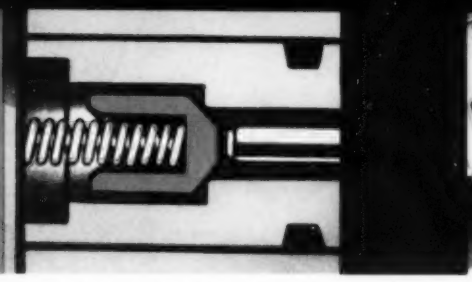
ZYTEL can be molded easily and economically into complex shapes, like the housing for this automatic valve assembly, which is used in modern home washers. ZYTEL makes possible dependable components that require practically no maintenance.



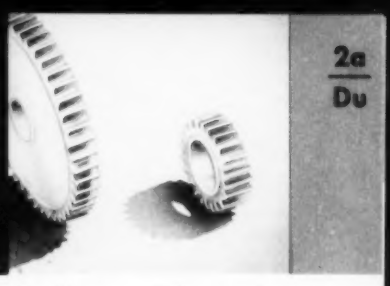
The resilience of ZYTEL keeps vibration from loosening these lightweight, durable, precision-machined fastenings shown above.



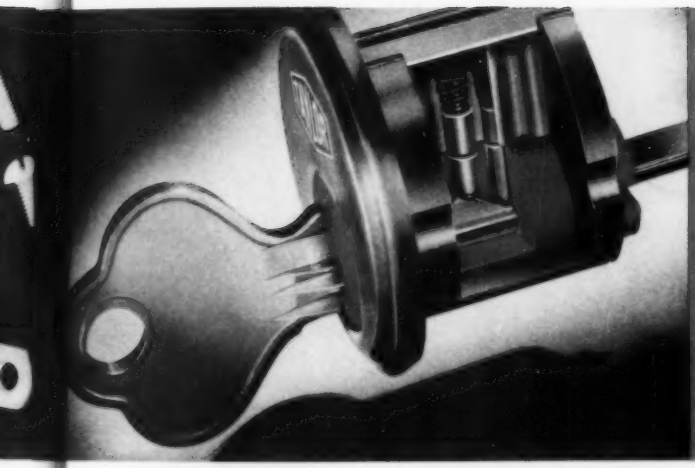
ZYTEL bearings and bushings have long-wearing surfaces and excellent impact strength. Because of low coefficient of friction, they need little or no lubrication. They are resistant to oils, gasoline and grease, and are tough and durable.



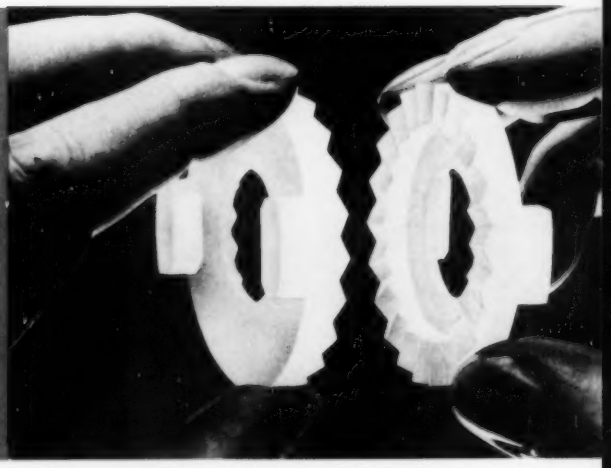
This leakproof check valve of ZYTEL nylon resin provides a tight seal even where there are slight imperfections in mating parts. It is wear resistant and does not become worn or grooved after repeated contact with the seat.



Sturdy gears of ZYTEL nylon resin not only operate quietly and efficiently, but also damp mechanical vibration. These durable gears can be fabricated economically—either by injection molding, or by machining from extruded bar stock.



The cylinder plug for this door lock is molded of DuPont ZYTEL nylon resin. The corrosion-resistant, weatherproof cylinder plug will not stick, and is not subject to electrolytic action. In addition, lubrication is not necessary, and long service life can be expected.



These clutch facings of ZYTEL revolve at 1750 rpm, transmitting 75 in.-oz. of torque, engaging and disengaging continuously 24 hours a day at up to 40 cycles per minute. Yet facings of ZYTEL last nearly six times as long as metal facings.

DU PONT

BETTER THINGS FOR BETTER LIVING THROUGH CHEMISTRY

ALATHON®

POLYETHYLENE RESINS

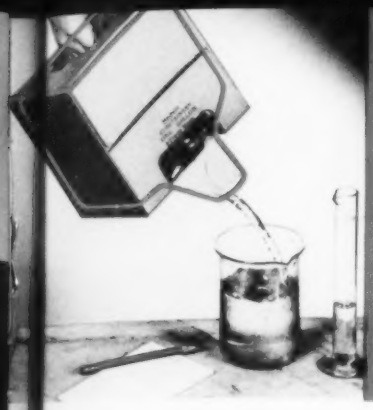


Tough, flexible ALATHON makes possible many new, improved products like this squeeze can for a liquid detergent.

application:

ALATHON polyethylene resins are unaffected by mineral acids and most organic solvents. Easily formed into thin sections, ALATHON is well suited for bottles, flasks and flexible tubing for liquid, paste and powdered products. The low power factor of ALATHON, low inductive capacity, inertness to ozone, and excellent dielectric qualities at all frequencies adapt it to wire and cable insulation and jacketing, and many other electrical applications. Its flexibility and durability make ALATHON an ideal material for plastic piping.

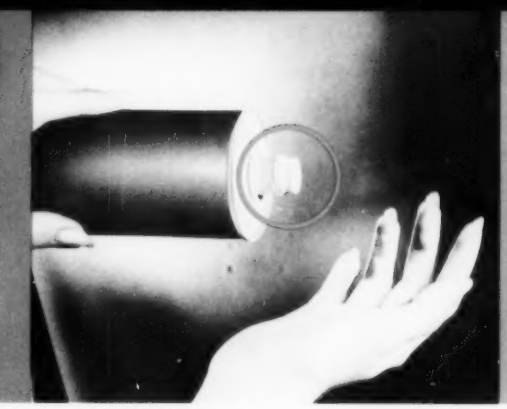
ALATHON is available in a wide range of formulations, each having certain outstanding properties which render it particularly suitable for specific applications. Two formulations, marked by superior film transparency, stiffness, impermeability and heat resistance, not only improve the characteristics of finished films, bottles, wire and paper coatings of ALATHON, but also permit use of faster, more economical production techniques. The new ALATHON 31 resin is especially developed for thermo-forming operations.



This container of ALATHON inside a corrugated paper box can be used for shipping, storing and dispensing many liquids. The flexibility, chemical resistance, light weight, and ease of processing of ALATHON make this container effective and practical.



Flexible pipe of ALATHON has outstanding long-term burst strength. It withstands repeated cycles of freezing, varying pressures, and contact with corrosive soil chemicals. It is lightweight, easy to handle—even bends around corners.



Molded of lightweight, unbreakable ALATHON, this nozzle pours freely when the cap is tipped, yet won't drip. The nozzle of ALATHON resists detergents, rust inhibitors, and countless other materials usually packaged in such containers.

2a
Du

description:

ALATHON is the registered trademark for Du Pont polyethylene resins. The lightest of the commercially available resins, polyethylene has a feel, appearance, and molecular structure similar to that of paraffin wax. ALATHON is supplied by Du Pont, in the form of eighth-inch cubes, to paper coaters, wire extruders, molders and fabricators of film.

The white, translucent resin is non-toxic, essentially odorless and tasteless. It has a low rate of water vapor transmission and low water absorption. Chemically, ALATHON is inert to solvents and most chemicals (including food acids) at room temperatures. It is affected only by certain oxygenated organics, aromatic hydrocarbons and chlorinated hydrocarbons, which cause it to swell at room temperature and dissolve at high temperature.

properties:

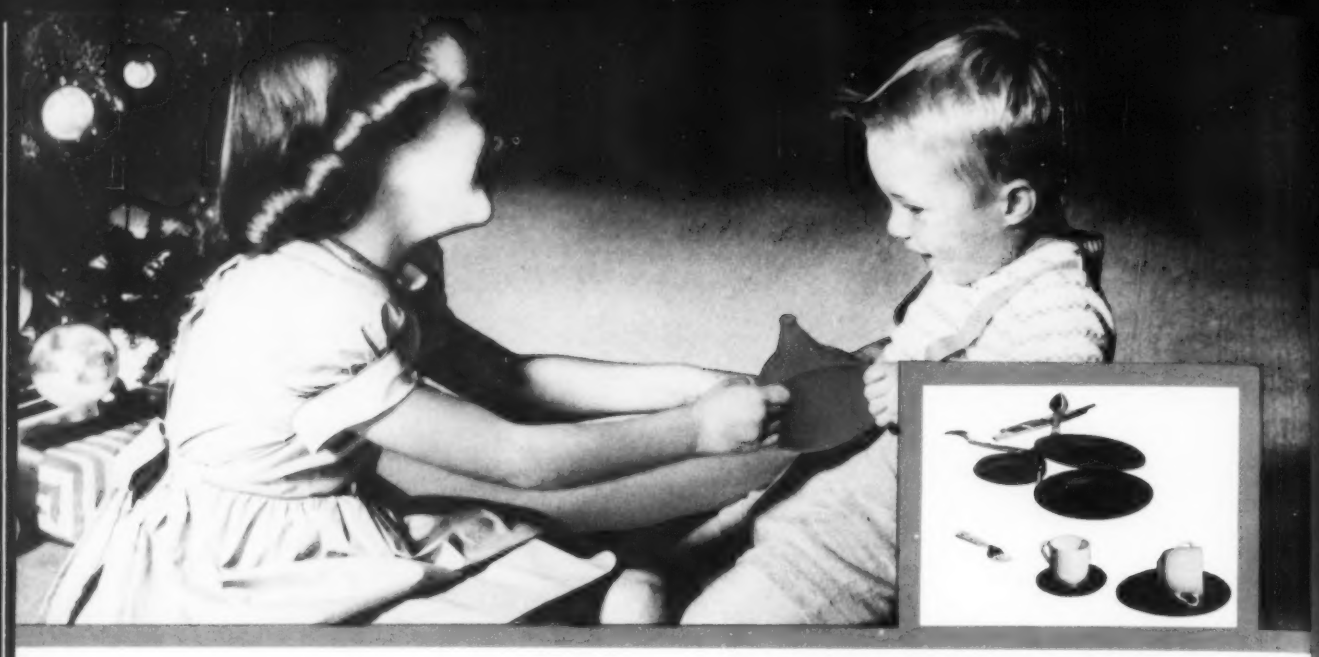
The non-polar molecular structure of ALATHON gives it excellent dielectric characteristics at all frequencies. The resistivity of the resin is high, its power factor and inductive capacity are low, and it is comparatively inert to ozone.

ALATHON is inert to many chemical reagents, being substantially unaffected at room temperatures by concentrated hydrochloric, or hydrofluoric acids, for example.

ALATHON remains flexible at low temperatures. It withstands temperatures as low as —95°F. without becoming brittle.



Insulation and jacketing of ALATHON have outstanding electrical characteristics. This wire is easy to handle, lightweight and pliable. The jacket of ALATHON is tough and weather resistant, and has superior heat and abrasion resistance.



Toys, such as this tea set, are safe, attractive and practically indestructible when made of ALATHON. Tasteless, odorless, non-toxic, and water and shock resistant, ALATHON can be molded economically into complex shapes.

A new formulation, black ALATHON 5F is available for film and paper coating, where resistance to outdoor weathering is important.

forming and working:

ALATHON molding powders are fabricated by any of the standard techniques—injection molding, compression molding, or by extrusion. A film of ALATHON may be applied to paper, cloth or other flexible materials by extrusion coating, and sheeting of ALATHON may be vacuum-formed.

Solid shapes of ALATHON may be machined from bar stock, rod or tube with the standard tools and techniques used in working soft metals, and separate pieces of ALATHON can be joined by heat welding, or by spin welding.

Housewares of ALATHON are colorful and shatterproof. Despite its flexibility, ALATHON is strong, even in thin sections. And ALATHON has the virtue of withstanding high temperatures—these wares can be sterilized in scalding water without damage.

Pop this convenient pouch package into water. Cook with no trace of food odor. Cool and serve. This new food package consists of three layers: printed aluminum foil, a special 15-lb. paper, and a one mil interior coating of a Du Pont ALATHON resin.

Here a coating of ALATHON, permanently bonded to the aluminum jacketing of industrial pipe, provides protection against moisture and acid fumes. Without ALATHON, installation of such pipe in corrosive atmospheres would be impractical.



DU PONT

LUCITE®

ACRYLIC RESINS

2a
Du



Control panels for this new washer and dryer are molded of durable, crystal-clear, sparkling LUCITE.

application:

Due to its outdoor stability and optical characteristics, LUCITE has wide application on architecture, signs and displays, and lighting. Lighting surfaces of LUCITE provide high visibility without glare. Smooth, ribbed or pebbled surfaces of LUCITE in curved or flat sections can be formed to give unusual yet efficient lighting effects.

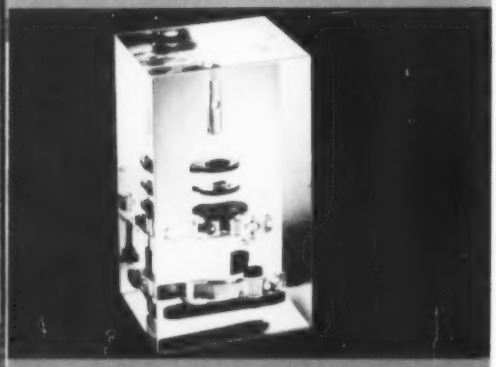
LUCITE acrylic resin can be colored, or sheets of LUCITE can be back-painted, for use in signs. It can be extruded in any desired length for effective designs of indoor or outdoor signs.

Extraordinarily strong, and capable of being economically injection molded to close tolerances, clear LUCITE can be used as an optical lens material. It comes in gemlike colors for such automotive uses as tail-light lenses and parking lights; for use in decorative emblems and parts for appliances; for specialty packaging and jewelry applications.

LUCITE is supplied by Du Pont in several formulations, each having properties which suggest specific applications. One of the newest formulations permits molding temperatures 30°F. to 50°F. higher than previous acrylic resins, with increased fluidity during processing, and improved stability after. Yet it retains the beauty and weather resistance which characterize all products made of LUCITE.



Because it is made of LUCITE, the case of this electric razor will retain its jewel-like appearance for years.



Products are embedded in LUCITE for instructive and attractive exploded-view effects such as this one.



Optically designed indoor lighting fixtures of LUCITE provide low brightness with even diffusion of light.



750 luminaires of LUCITE on this 7½ mile stretch — longest fluorescent street-lighting installation in the world.

description:

LUCITE is the registered trademark for Du Pont acrylic resins. LUCITE is available in a range of molding powders which offer a variety of molding characteristics and properties, and a broad selection of transparent, translucent and opaque colors. The powders are solid and granular, cut to approximately ⅛" cubes for injection molding or shaped in minute spherical granules for compression molding. LUCITE acrylic resins are also available for extrusion.

properties:

LUCITE is light in weight—about one-third the weight of glass—with relatively high impact strength, even at low temperatures. LUCITE can be injection molded into patterns of extreme intricacy. Moldings of LUCITE are form-stable at temperatures of 200°F. and, in some cases, higher. As with other thermoplastics, however, the tensile strength of this resin decreases with severe temperature increases.

LUCITE has a low thermal conductivity, about that of rubber. Its coefficient of linear thermal expansion is about eight times that of steel, and ten times that of glass.

LUCITE has superior optical properties. It transmits 92% of the light striking it. This clarity is not diminished by age, sunlight or moisture.

The combination of this transparency with a highly polished surface finish enables LUCITE to "pipe" light with very little leakage, around angles as acute as 42°, or curves with radii three times or more the thickness of the material. "Edge-lighting" effects

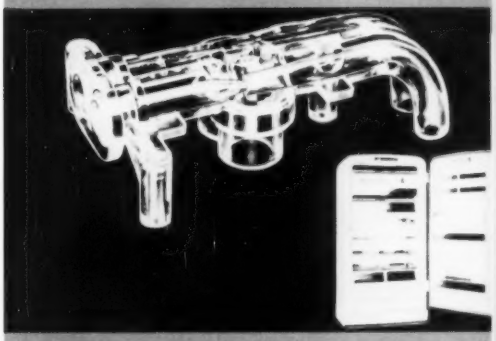
are also possible with LUCITE. LUCITE has outstanding dielectric strength, does not track, and has exceptional corona resistance. Because these properties are relatively unaffected by weather or aging, insulations of LUCITE will give long, effective service.

Chemically, LUCITE is resistant to dilute alkalies, many strong acids, and numerous organic chemicals. Most impressive is its resistance to water. The strength and toughness of LUCITE are virtually unaffected by immersion in either water or water vapor. LUCITE is odorless, tasteless, non-irritating, and non-toxic.

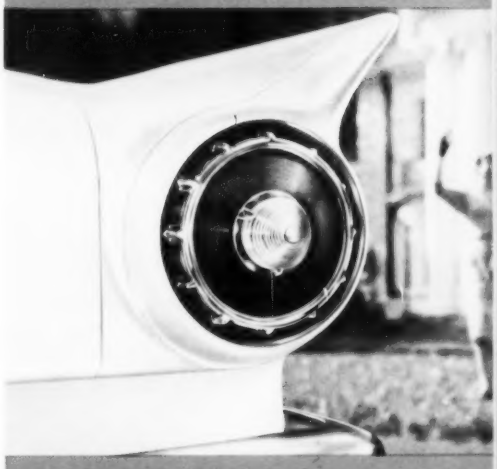
forming and working:

Molding powders of LUCITE may be fabricated either by injection or compression molding, or by extrusion. Molded LUCITE may be shaped with woodworking equipment in much the same fashion as wood or soft metal. LUCITE may be sawed, punched, stamped, drilled, threaded, routed or formed. Pieces of it may be joined either by cementing or by heat-welding. LUCITE may also be bonded to other materials with suitable commercial adhesives. Parts of LUCITE may also be assembled by spin-welding. A good joint between two pieces of LUCITE is strong, transparent, and practically invisible.

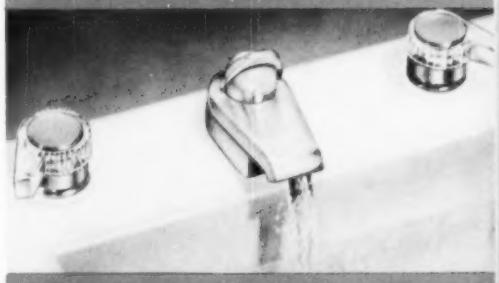
LUCITE may be decorated with paint, stains, silk screen designs, or by sand-blasting, carving or etching. To obtain stable colors, certain pigments or dyes may be added to powdered LUCITE, before it is molded. In addition, LUCITE acrylic resin is supplied in a range of transparent, translucent and opaque colors.



LUCITE is readily molded into complex shapes like this juice-mixing valve for a refrigerator. Its sparkling clarity makes the valve easy to inspect for cleanliness. LUCITE resists chemical action of fruit juices and other food substances.



Parts molded of LUCITE make a major contribution to today's smartly styled, efficiently designed automobiles. This handsome, durable tail-light lens of LUCITE adds a note of distinction to a popular model. Its inner surfaces are molded to precision contoured lenses.



The sparkling clarity of Du Pont LUCITE acrylic resin adds beauty to these plumbing fixture knobs. The toughness, transparency, durability and eye appeal of LUCITE help designers develop original new products.



Du Pont engineering materials

At Chestnut Run, Delaware, Du Pont maintains its Polychemicals Sales Service Laboratory, where continued study of basic plastics engineering materials occurs. The laboratory enables Du Pont to help molders and end-users improve processing techniques, to continue to improve the various properties of the above materials, and to investigate new uses for them. This building contains 62,000 square feet and is equipped with the most modern and efficient apparatus and equipment available.

district offices

7250 N. Cicero Ave., Lincolnwood
Chicago 30, Illinois
INdependence 3-7250

2930 E. 44th Street
Los Angeles 58, California
LUdlow 2-6464

350 Fifth Avenue
New York 1, New York
LOngacre 3-6400

13000 W. Seven Mile Road
Detroit 35, Michigan
UNiversity 4-1963

140 Federal Street
Boston 10, Massachusetts
HAncock 6-1711

1616 Walnut Street
Philadelphia 3, Pennsylvania
Kingsley 6-4600

818 Olive Street
St. Louis 1, Missouri
CEntral 1-8532

Teflon®
FLUOROCARBON RESINS

Zytel®
NYLON RESINS

Alathon®
POLYETHYLENE RESINS

Lucite®
ACRYLIC RESINS

comparative characteristics chart

chemical	*mechanical*	*electrical*	*structural*	*decorative*
Completely inert to all chemicals and solvents normally encountered in industry. Impervious to water.	Tough over a range of temperatures from — 450 to + 500° F. Non-adhesive. Low friction coefficient. Self-lubricating.	Outstanding in all electrical properties at all frequencies.	Tough and resilient. Resistant to impact. Impervious to weather.	Can be colored. Useful for color coatings to aid identification.
Unaffected by common solvents, alkalies, dilute mineral acids and most organic acids.	Tough and resilient at low temperatures. Requires little or no lubrication. Resists abrasion.	Good dielectric properties at commercial power frequencies.	Strong and durable. Good form stability. Light in weight.	Good color possibilities. Attractive texture.
Excellent chemical and water resistance.	Tough and flexible over wide range of temperatures.	Excellent dielectric properties over wide frequency and temperature range.	Good strength and toughness. Free from taste, odor and toxicity. When black pigmented resists weather. Resists impact. Very light weight.	Easily colored. Attractive translucent texture.
Resistant to dilute alkalies, many strong acids and other chemicals.	Rigid. Good dimensional stability.	Good dielectric properties at all commercial power frequencies.	Unexcelled weatherability. Shatter resistant. Good dimensional stability. Light in weight. Free from taste, odor and toxicity.	Transparent. Available in range of colors. Transmits and "pipes" light. Unusual beauty.

PROPERTIES OF DU PONT *engineering materials*

footnotes Tests have been performed by A.S.T.M. methods unless otherwise indicated. Data shown are average values and should not be used for specifications.

*Test not applicable.

(1) Other compositions of "Teflon," "Alathon," "Zytel," and "Lucite" are available for special requirements. The types shown here are the most widely used at the present. The properties shown here apply to standard compositions.

(2) "Alathon" 5 differs from 10 in the fact that the former contains an antioxidant.

(3) Hardness of "Alathon" and "Teflon" determined by Shore durometer, A.S.T.M. method D676-49T.

(4) Term "creep in flexure" is a measure of the deformation under a prolonged standard load. Results here represent mils deflection in 24 hrs. of a ⅛" x ½" bar, 4" span, center-loaded flatwise to 1000 lb./sq. in., minus the initial deflection.

(5) Thermal conductivity measured by Cenco-Fitch apparatus.

(6) Deformation under load for "Alathon" determined at 100 lb./sq. in. (standard for non-rigid plastics).

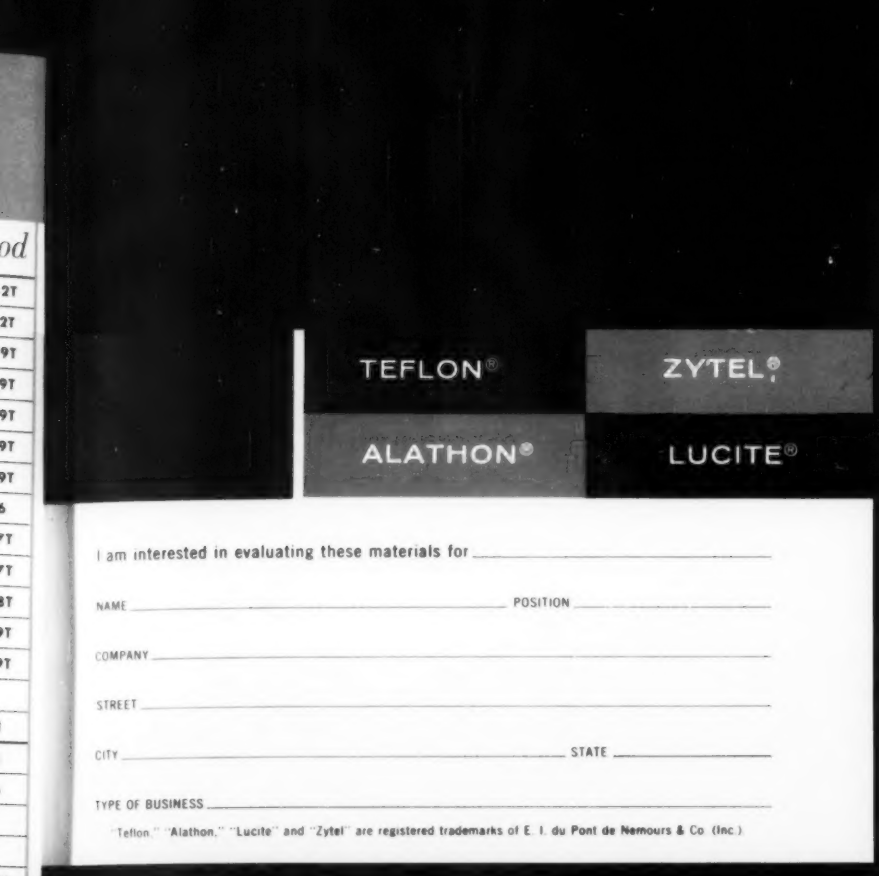
(7) The outdoor durability of black-pigmented "Alathon" is excellent.

(8) Tensile strength in oriented film may be as high as 15,000 lb./sq. in.

(9) Value is 1000-2000 volts/mil in thicknesses of 5-12 mils.

(10) Softening point, Vicat.

	property	*units*	*method*
mechanical	Tensile strength, —70°F.	LB./SQ.IN.	D638-52T
	73°F.	LB./SQ.IN.	D638-52T
	170°F.	LB./SQ.IN.	D638-49T
	Elongation, —70°F.	%	D638-49T
	73°F.	%	D638-49T
	170°F.	%	D638-49T
	Modulus of elasticity, 73°F.	LB./SQ.IN.	D638-49T
	Shear strength	LB./SQ.IN.	D732-46
	Impact strength, Izod, —40°F.	FT.-LB./IN.	D256-47T
	73°F.	FT.-LB./IN.	D256-47T
	Stiffness, 73°F.	LB./SQ.IN.	D747-48T
	Flexural strength, 73°F.	LB./SQ.IN.	D790-49T
	Compressive stress at 1% deformation	LB./SQ.IN.	D695-49T
	Creep in flexure		(4)
	Hardness, Rockwell		D785-51
thermal	Flow temperature	°F.	D569-48
	Coefficient of linear thermal expansion per °F.		D696-44
	Thermal conductivity	B.T.U./hr./sq. ft./°F./in.	(5)
	Specific heat		
	Deformation under load, 122°F., 2000 lb./sq.in.	%	D621-48T
	Heat-distortion temperature, 264 lb./sq.in.	°F.	D648-45T
	66 lb./sq.in.	°F.	D648-45T
electrical	Dielectric strength, short-time	V/MIL	D149-44
	step-by-step	V/MIL	D149-44
	Volume resistivity	OHM-CM.	D257-49T
	Dielectric constant, 60 cycles		D150-47T
	10^3 cycles		D150-47T
	10^4 cycles		D150-47T
	10^5 cycles		D150-47T
	Power factor, 60 cycles		D150-47T
	10^3 cycles		D150-47T
	10^4 cycles		D150-47T
	10^5 cycles		D150-47T
optical	Index of refraction	n_D	D542-42
	Luminous transmittance, illuminant C, ⅛ in.	%	D791-49T
	Transmittance at 4500 Å, ⅛ in.	%	D791-49T
	Haze	%	D1003-49T
miscellaneous	Water-absorption	%	D570-42
	Flammability	IN./MIN.	D635-44
	Specific gravity		D792-48T
	Mold shrinkage	IN./IN.	
	Compression ratio		D392-38
	Resistance to weathering		
	Basic color		
	Resistant to		
	Not resistant to		


TEFLON®
ZYTEL®
ALATHON®
LUCITE®
I am interested in evaluating these materials for
NAME
POSITION
COMPANY
STREET
CITY
STATE
TYPE OF BUSINESS
"Teflon," "Alathon," "Lucite" and "Zytel" are registered trademarks of E. I. du Pont de Nemours & Co. (Inc.)

No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid by Addressee

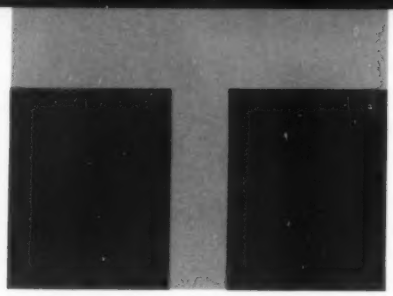
BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 9, WILMINGTON, DEL.

E. I. DU PONT DE NEMOURS & CO. (Inc.)
POLYCHEMICALS DEPARTMENT
DU PONT BUILDING, ROOM 5357
WILMINGTON 98, DELAWARE

ZYTEL® nylon resins (1)				TEFLON® tetrafluoroethylene resins (1)	ALATHON® polyethylene resins (1)	LUCITE® acrylic resins (1)		
molded 101	molded 31	molded 63	molded 42	molded 1	molded 10 (2)	molded 40 and 140	molded 29 and 129	molded 30 and 130
15,700	12,900	13,000		6,500-9,000	4,750	14,500	14,500	14,500
10,500	7,000	7,400	12,000	2,000-5,500 (8)	1,900	10,600	10,000	9,500
7,600	6,760	5,000		1,500-4,000	850	5,000	4,300	2,800
1.6	2.0	8.0		20-60	60	2	2	2
90	90	300	100-200	200-400	600	3-5	3-5	3-5
320	320	400		400-550	600	80	90	100
400,000	260,000	38,000	400,000	62,000-74,000 (flex)	35,000	400,000	400,000	400,000
9,600	8,400	5,700	9,600		2,750	9,400	9,000	7,500
0.4	0.6	0.9		2.0	0.8	0.3	0.3	0.3
1.0	1.0	> 16	1.3	3.0	did not break	0.3	0.3	0.3
				50,000-90,000	27,000	430,000	410,000	340,000
13,800	8,000	1,000	13,800	did not break	*	16,500	15,500	14,500
4,900	3,000	800	4,900	600		4,800	4,600	4,600
					*	5	5	5
R118	R111	R83	R118	D50-D65 (3)	C81, D48 (3)	M103	M95	M88
				*	201 (10)	304	274	257
5.5×10^{-5}	5.5×10^{-5}	8.2×10^{-5}	5.5×10^{-5}	5.5×10^{-5}	9×10^{-5}	3×10^{-5}	4×10^{-5}	4×10^{-5}
1.7	1.5	1.9	1.7	1.7	1.75 (5)	1.4	1.4	1.4
0.4	0.4	0.4	0.4	0.25	0.55	0.35	0.35	0.35
1.4	4.2	20	1.4	25	0.6 (6)	0.4	0.7	
150	135		150		*	202	180	166
360	300	100	360	250	121	216	190	175
385	470	420	385	400-500 (9)	460	400	400	400
340	410	400	340		420	370	370	370
4.5×10^{13}	4×10^{14}	5×10^{13}		$> 10^{19}$	$> 10^{15}$	$> 10^{15}$	$> 10^{14}$	$> 10^{14}$
4.1	4.6	10.7		2.1	2.3	3.5	3.9	3.9
4.0	4.5	8.3		2.1	2.3	3.8	3.4	3.6
3.4	3.5	4.5		2.1	2.3	3.3	2.9	2.9
				2.1	2.3	2.8	2.7	2.8
0.014	0.04	0.19		< 0.0003	0.0005	0.055	0.042	0.042
0.02	0.04	0.18		< 0.0003	0.0005	0.040	0.042	0.042
0.04	0.03	0.14		< 0.0003	0.0005	0.024	0.025	0.027
				< 0.0003	0.0005	0.009	0.011	0.012
					1.51	1.49	1.49	1.49
*	*	*		*	*	> 92	> 92	> 92
*	*	*		*	*	90	90	90
*	*	*		*	*	< 3	< 3	< 3
1.5	0.4	2.0		0.005	0.014	0.25	0.28	0.29
self-extinguishing	self-extinguishing	self-extinguishing	self-extinguishing	nonflammable	0.94	1.2	1.2	1.2
1.14	1.09	1.13	1.14	2.1-2.2	0.92	1.18	1.18	1.18
0.015	0.015			*	0.02-0.05	0.002-0.006	0.002-0.006	0.002-0.006
2.1	2.2	2.5		*	2.1-3.6	1.8-2.2	1.8-2.2	1.8-2.2
good	good	good	good	excellent	fair (7)	excellent	excellent	excellent
light cream translucent	cream translucent	pale straw translucent	cream translucent	light opaque	white translucent	water white transparent	water white transparent	water white transparent
esters, ketones, common solvents, alkalies, weak acids	esters, ketones, common solvents, alkalies, weak acids	esters, ketones, alkalies	esters, ketones, common solvents, alkalies, weak acids	all chemicals except molten alkali metals and fluorine	water, acids, alkalies, oxygenated solvents	water, weak acids, weak alkalies	water, weak acids, weak alkalies	water, weak acids, weak alkalies
phenol, formic acid, concentrated mineral acids	phenol, formic acid, concentrated mineral acids	phenol, alcohols, formic acid, mineral acids	phenol, formic acid, concentrated mineral acids	molten alkali metals and fluorine	chlorinated solvents, aliphatic and aromatic hydrocarbons	lower ketones, esters, aromatic hydrocarbons, strong acids, strong alkalies	lower ketones, esters, aromatic hydrocarbons, strong acids, strong alkalies	lower ketones, esters, aromatic hydrocarbons, strong acids, strong alkalies

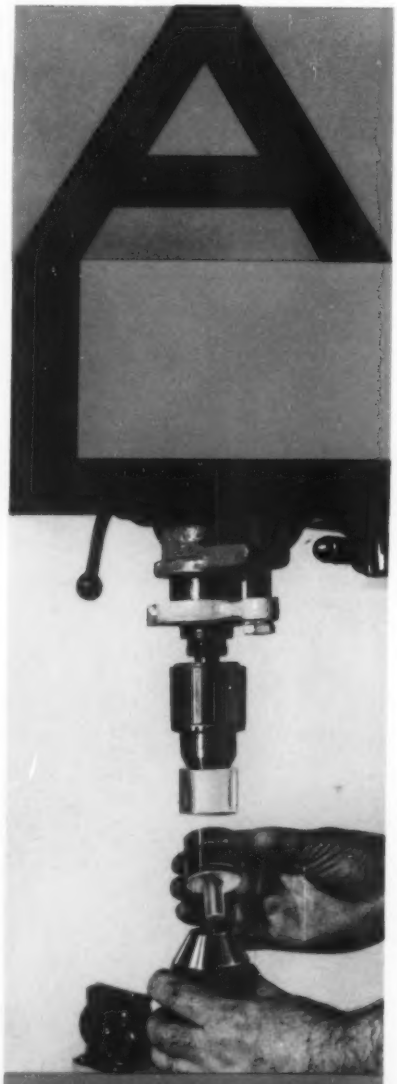
Information card soliciting inquiries for more information is enclosed.



TEFLON®
FLUOROCARBON RESINS



ZYTEL®
NYLON RESINS



ALATHON®
POLYETHYLENE RESINS

LUCITE®
ACRYLIC RESINS

The applications shown in this booklet are uses in which the outstanding qualities of the respective resins are illustrated.

To find which of the resins will best suit your needs, project the basic features of these applications to the problems your products involve.

For more information, call the nearest Du Pont district office, listed on page 16. Or contact E. I. du Pont de Nemours & Company, Inc., Polychemicals Department, Wilmington 98, Delaware.

Spin-welding, an unusual but relatively simple fabricating technique for plastics, recently improved and applied to new applications at Du Pont's Sales Service Laboratory near Wilmington, utilizes frictional heat, generated by the rotational rubbing of two surfaces, to melt and join them together.

This improved technique works especially well with thermoplastic materials such as Du Pont ZYTEL® nylon resin, LUCITE® acrylic resin and ALATHON® polyethylene resin.

The Du Pont Company assumes no obligation or liability for any advice furnished by it, or results obtained with respect to these products. All such advice is given and accepted at the buyer's risk. Du Pont warrants that the materials themselves do not infringe the claims of any United States patent, but no license is implied; nor is any further patent warranty made.

DU PONT
REG U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistr*

LUMINOUS PLASTIC RESINS that are BRIGHT at NIGHT

For the premier in luminescent plastic molding powders

use

"PAULITE" PHOSPHORESCENT

POLYSTYRENE · POLYETHYLENE · POLYVINYL

TENITE I & II* LUCITE

THE PREMIERE IN LUMINESCENT PLASTICS
PAULITE

Reg. U. S. Pat. Off.
REG. DOM. of CANADA

Long Lasting Luminescence

Articles molded from "PAULITE" emit a warm, friendly glow in the darkness. This after-glow lasts for as many as 10 or more hours, depending upon the type and intensity of activation.

and the new

"DERBYLITE" FLUORESCENT Molding Powders

DERBYLITE
Reg. U. S. Pat. Off.

REG. DOM. of CANADA

FLUORESCENT MOLDING POWDERS AND PRODUCTS

The Hallmark of vivid Daylight Fluorescent colors, stabilized for outdoor use with or without black light.

Easy to use Luminous Plastic Resins come ready for immediate molding. You handle them just as you would any other thermoplastic molding compounds—they require no special treatment before or during molding. Finished pieces have a glossy surface. Your orders will be custom-made. The materials used are non-toxic.

EXCELLO

Luminous Vinyl Sheets

.002" up to .080"

Meeting Military Specifications

EXCELLO

For complete information about the various varieties and how they can increase the saleability of your products, write today.

LUMINOUS RESINS INCORPORATED

* Reg. U.S. Pat. Off.

• 166 W. WASHINGTON STREET
• CHICAGO 2, ILLINOIS
• TELEPHONE: DEarborn 2-4667

Acrylics

BY F. J. GLAVIS* and HELEN F. TUCKER*

Acrylics constitute a family that comprises monomers and polymers of acrylic, substituted acrylic, and methacrylic acids, their salts, esters, and other derivatives, such as nitriles and amides.

Acid monomers and polymers: Acrylic acid, $CH_2 = CHCOOH$, is a corrosive, weak acid, available in essentially anhydrous form (glacial). Reactions of acrylic acid are typical of normal acid functions (ester, salt, anhydride, and acid chloride formation) and of the unsaturated function (addition of halogens, amines, mercaptans; Diels-Alder reaction). All reactions are qualified by the polymerizable nature of the molecule.

Polyacrylic acid, available as an aqueous solution in different viscosity grades and as an anhydrous powder, is a water-soluble polymer that gives hard, brittle, clear films. This product is capable of undergoing chemical reactions involving the acid function, such as salt formation and esterification, insolubilization being achieved in the latter instance by the use of polyfunctional alcohols.

Methacrylic acid, available in anhydrous form, is similarly amenable to reaction of the two functional groupings in the molecule as well as to polymerization.

Both acrylic and methacrylic acid are used in the modification of the properties of polymers through incorporation of varying amounts of these monomers in copolymerization reactions. Improved hardness, solvent resistance, and increased hydrophilicity may be obtained. Introduction of the acid group permits vulcanization of the polymer with zinc oxide.

Salts: Monomeric salts may be prepared by neutralization of the corresponding acid or by suitable saponification of the appropriate monomeric ester. Solid sodium methacrylate is currently available.

Polymeric acrylic salts may be prepared by 1) neutralization of the polymeric acids; 2) polymerization of the monomeric salts; 3) saponification of the polymeric acrylic esters; and 4) alkaline hydrolysis of the polymeric nitrile. For example, sodium polyacrylate made by the saponification of polyacrylonitrile is available from many sources. The potassium and ammonium salts are also produced. The polymeric salts are water-soluble polyanionics, giving hard, brittle, clear, hygroscopic films. In the presence of other cations, they show ion-exchange reactivity. The presence of acrylic salts as components of a copolymer system may affect the properties of the product so formed by alteration of the hydrophilic nature of the polymer, by insolubilization with polyfunctional cations, or by modifying hardness and brittleness.

Esters: A wide range of monomeric acrylic esters is available, with large quantities of methyl and ethyl acrylates and methyl methacrylate now being produced. Other available esters include butyl, 2-ethylbutyl, 2-ethylhexyl, octyl, methoxyethyl, ethoxyethyl, 3-ethoxypropyl and 2-diethylaminoethyl acrylates and ethyl, butyl, hexyl, decyl-octyl, lauryl, stearyl, 2-dimethylaminoethyl, and 2-diethylaminoethyl methacrylates. These esters are capable of undergoing reactions of the ester group, and of the unsaturated system, including polymerization. Variation of the molecular make-up of copolymers, involving different acrylate and methacrylate esters as well as other polymerizable monomers, permits wide variations of physical properties.

The polymeric esters may be considered from the point of view of these polymerization methods:

1) The monomeric esters can be

* Research Laboratories, Rohm & Haas Co., Washington Sq., Philadelphia, Pa.

Recent Developments and References were prepared by the editors.

By switching from glass to acrylic glazing (*Plexiglas*, Rohm & Haas Co.) for the drop side-window in the motorman's cab of suburban multiple-unit cars, the Pennsylvania Railroad is saving $3500 a year in replacement costs. The lightweight plastic panes also facilitate opening and closing.

A new line of cast acrylic sheet (*Larcrylic*, Larc Products, Inc.) is produced in clear, white, and colors in standard sizes from 48 by 48 to 100 by 120 in., 0.06 to 0.375 in. thick.

An improved methacrylate molding material (*Lucite 140*, Du Pont) has a heat stability that permits molding at temperatures 40° higher than was formerly possible. The higher heat stability of the resin permits one of three possibilities: 1) speed-up of the molding cycle; 2) filling of more complicated molds; or 3) reduction of pressure to eliminate flash.

Acrylic resin molding powder (*Lucite*, Du Pont) is now available in diamond-shaped pellets, ⅛ in. long and ⅛ in. thick. The new shape improves pouring, handling by pneumatic hopper loaders, and metering into extruders and injection molding machines. It gives greater shot-to-shot uniformity of injection molded parts and saves space in packing and storing. It has approximately 10% higher bulk density than cube-cut powder and lower moisture content, making possible processing at higher temperatures without bubbling or splay in molded parts. A virtual absence of fines helps prevent discoloring under heat.

Cast acrylic sheets (*Plexiglas RL*, Rohm & Haas Co.) in sizes up to 8½ by 10 ft. are furnished in both colorless transparent and in translucent colors. These large sheets are used for internally illuminated signs, large-area glazing, fluorescent light diffusers, dome skylights, and other architectural applications. They have the same surface standards and optical quality as commercial grade, untrimmed, unmasked acrylic sheet (*Plexiglas R*) and also the same physical, chemical, and weathering properties.

A new cleaner and polisher (*Acrakleen*, Schwartz Chemical Co., Inc.) improves pilot vision by removing fine scratches and haze from plastic windshields on aircraft and boats. The product is effective on all kinds of plastics, including acrylics, polystyrene, acetate, and vinyls.

A new acrylic lacquer (*Resolac*, Resolite Corp.) restores luster to weather-dulled reinforced plastics panels. The lacquer, composed of acrylic resins in an organic solvent, can also be used to deepen the color, reducing light and heat transmission.

High-solids acrylic thickeners and dispersants (*Acrysol ASE-75* and *ASE-60*, Rohm & Haas Co.) can be converted at the point of use to a dilute viscous salt, thus reducing shipping costs and simplifying handling. One type (*ASE-75*) will be used in the manufacture of paints, inks, adhesives, paper coatings, textile backings, floor finishes, grinding compounds, and other applications for which dry powders or low-solids thickeners are now used. It will also be used to advantage in the areas where polyacrylates are now employed. Solutions of ASE-60 suspend pigments, abrasives, and other divided solids.

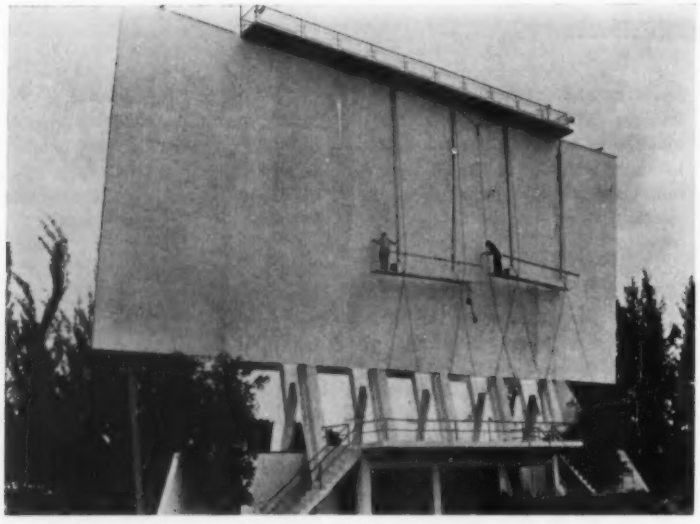
polymerized in bulk by casting techniques to give sheet materials.

2) Suspension polymerization of the monomeric esters has been used to prepare molding powders. The polymer can be produced in discrete particles of well-defined dimensions by control of the polymerization conditions. The molding powders are formed into hard, transparent, clear objects by applying heat and pressure in dies of the desired shape.

3) A third method involves the polymerization of acrylic esters in organic solvents. A large range of solvents has been used for the preparation of soluble polymers, the properties of which permit application in coating, adhesive, and lubricating oil compositions. By using different esters and combinations of esters, and modifications in the polymerization conditions, polymeric compositions having various solubilities result. These produce films that range from hard and brittle to soft and tacky.

4) By using emulsion polymerization techniques, a fourth type of polymer system has been made available. These stable dispersions of discrete particles of acrylic polymers may form films on drying. Depending upon the particle size of the polymer as well as upon its chemical composition, durable films may be obtained with varying hardness and tack.

Nitriles: Acrylonitrile monomer is readily available from multiple sources. The monomer is a liquid capable of ready polymerization, and is reactive by virtue of both its carbon-to-carbon unsaturation and its nitrile function. Polymerization, which may be effected in aqueous suspension or in solution, provides the basic material for the preparation of fibers (Orlon and Acrilan). Polyacrylonitrile is soluble in such solvents as dimethyl formamide, ethylene carbonate, tetramethylene sulfone, and aqueous solutions of thiocyanate salts, and may be formed into fibers by extruding a polymer solution into a coagulating bath such as water. Polyacrylonitrile may also be hydrolyzed with acid, caustic, or ammonia to form water-soluble hydrolysates as indicated previously in the discussion of polymeric acrylic salts. Acrylonitrile is not amenable to bulk polymerization, since the polymer is insoluble in the monomer. Acrylonitrile is useful in



Acrylic latex paint is applied to face of drive-in theater screen. Paint can take sun, wind, and rain without cracking. (Photo, Rohm & Haas)

copolymer systems to improve such properties as solvent resistance and hardness. Examples include copolymers of acrylonitrile with butadiene, styrene, and vinyl chloride.

Amides: Acrylamide and methacrylamide are available as solid materials. Both the monomers and polymers are susceptible to alkaline hydrolysis with the formation of ammonia and the corresponding acrylic salt. In addition, the amide function can be modified by reaction with formaldehyde to produce methylol acrylamide and methylene-bis-acrylamide, both of which are currently available. Also available is N-tert-butyl acrylamide. Polyacrylamide has been introduced as an industrial flocculant.

Alpha-halogenated esters: The methyl alpha-chloracrylate, derived from methyl acrylate, has been investigated extensively as a material that affords, on polymerization, a hard, clear, transparent sheet with a high softening point and resistance to surface abrasion.

The above chemical classification of the acrylics indicates the wide variety of properties that are obtainable with such materials. There are many instances in which minor proportions of acrylic monomers are useful in modifying the properties of polymer systems based on monomers other than acrylics. The following discussion of end uses will not include materials made with acrylic monomers in minor proportions, such as the butadiene rubbers, and copolymers with vinyl chloride, vinyl acetate, or with styrene.

Design of larger control panels using thin sections is made possible by increased upper molding limit available with new acrylic. (Photo, du Pont)



Applications

Sheets and molding powders: The properties exhibited by solid acrylic polymers, such as crystal clarity, high impact strength, formability, and resistance to sunlight, weather, and most chemicals, have led to widespread use in military and civilian applications. The fields of usefulness have also been broadened by availability in transparent, in translucent, and in opaque colors.

Acrylic sheet is the standard transparent material for canopies, windows, instrument panels, and searchlight and landing light covers on aircraft. Large sheets, edge-lighted, are used as radar plotting boards in shipboard and ground control stations. To keep pace with the increasingly severe service requirements of pressurized jet aircraft, new grades of acrylic have been developed that have improved resistance to heat and crazing. The stretching technique has made possible enhanced resistance to both crazing and shattering.

In the general field of merchandising, acrylics have become a major sign material for faces and letters, particularly for outdoor use where weather resistance is important. In addition, acrylics are used for counter dividers, transparent demonstration models of household appliances and industrial machines, display fixtures and cases, and vending machines.

The ability of acrylics to resist breakage and corrosion, and to transmit and diffuse light efficiently makes them beneficial in industrial and architectural applications. Industrial window glazing, safety shields, inspection windows, machine covers, and pump components are some of the uses commonly found in plants and factories. Dome skylights formed from acrylic sheet are an increasingly popular means of admitting daylight through the roofs of industrial, commercial, and public buildings and of private homes. Acrylics are employed to good advantage as the diffusing medium in lighting fixtures and large luminous ceiling areas. Shower enclosures and decorative partitions are other well-established applications. An expanding development is a window glazing panel with integrally formed louvers for the control of sun and sky glare.

In molding-powder form, acrylics are used extensively for the manufacture of automotive parts, such as taillight and stoplight lenses, medallions, nameplates, dials, instrument panels, and signal lights. The beauty and dura-

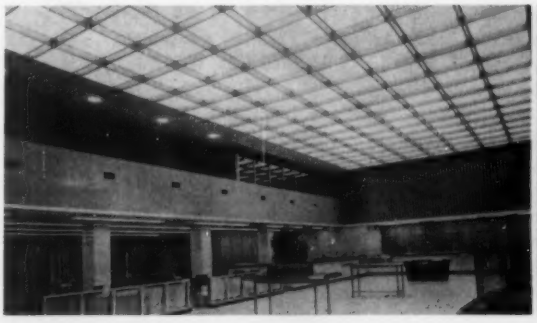
bility of molded acrylic parts have led to their wide use for nameplates, control knobs, dials, and handles on all types of home appliances, and for pen and pencil barrels and personal accessories, such as hairbrush backs. Covers for fluorescent street lights, jukebox panels, TV implosion shields, and other large-section moldings are being formed from acrylic powder. The extrusion of acrylic sheet from molding powder is particularly effective in the production of thin sheeting. Extruded sheets have also been used in such applications as sign-lighting, glazing, partitions, and shower enclosures.

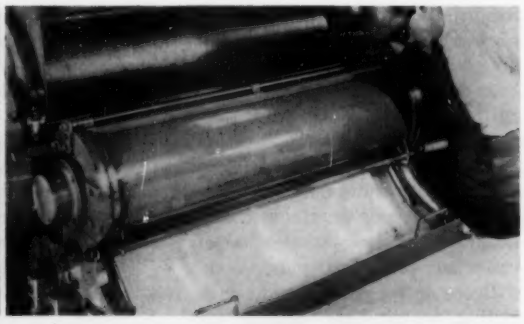
Advantage is taken of the transparency, strength, light weight, and edge-lighting characteristics of acrylics in the fields of hospital equipment, medical examination instruments, and orthopedic devices. The use of acrylic polymers in the preparation of dentures is an established practice. The embedment of normal and pathological tissues in acrylics for preservation and instructional use is an accepted technique, which has been extended to include embedment of industrial machine parts as sales aids, and the preparation of home decorative articles.

Elastomers: The use of acrylic esters in synthetic rubber formulations may be exemplified by a copolymer of ethyl acrylate with about 5% of a chlorine-containing monomer such as chloroethyl vinyl ether or chloroethyl acrylate. The vulcanized products combine outstanding heat resistance and oil resistance, and have found widest use as gaskets for automatic transmissions for gasoline engines. Vulcanizates of fluorinated acrylics are said to offer advantages in toughness and durability. Acrylate-acrylonitrile copolymers are also being manufactured for use as vulcanizable elastomers. The use of acrylonitrile in the nitrile rubbers continues to offer products of superior solvent resistance and durability. Polyblends of acrylonitrile-styrene resins with butadiene-acrylonitrile rubbers are used for pipes and fittings in industrial applications in which resistance to alkali and acid is required. Polystyrene-acrylonitrile rubber blends exhibit toughness and high impact strength, and impart improved formability to the sheet composition.

Ion exchange resins: Cation exchange resins may be produced by the polymerization of methacrylic acid in the presence of cross-linking agents, such as divinylbenzene. These acrylic-based ion exchange resins are especially adaptable for sodium therapy, for pharmaceutical applications that involve the recovery of antibiotics, and in the treatment of sugar solutions. In the latter application the weak acid character of the resin does not cause the inversion of the sucrose.

Textiles: Considerable work has been undertaken to overcome certain difficulties encountered in the acrylic fibers, such as Orlon and Acrilan. Fiber studies have been concerned with modifications in molecular formulation to achieve greater dye receptivity, and mechanical modifications to reduce fibrilation and subsequent apparent color variations in dyed fabrics. Blends of polyacrylonitrile with such fibers as wool, rayon, and acetate provide a means of obtaining mixed fibers with the







Lighting and glazing applications—both indoors and outdoors—stand out as major market for acrylic materials. Typical indoor applications include large-area luminous ceiling made up of diffusing panels extruded of acrylic (top, left) and sight panels formed of clear acrylic sheeting that protect materials being processed while permitting continuous inspection (top, right). Outdoor applications include formed signs silk screened in multiple colors (left) and 6-ft. molded acrylic enclosures for fluorescent lights used to illuminate bridges, highways, etc. (right). (Photos, Rohm & Haas)



dyeability and other properties characteristic of the fiber types present in the blend. Certain synthetic fiber blends have been developed to simulate fur. Modification of cotton to give improved characteristics, such as fungus resistance and higher heat resistivity, has been achieved by treatment of the cotton with acrylonitrile.

Acrylics are established materials for sizing of fibers, with polyacrylic acid used extensively in the nylon field. Acrylate dispersions provide highly desirable types of finishes. Applied to cotton and rayon, they contribute a firmer hand, improved tensile and tear strength, and better abrasion and wear resistance. They are not easily removed by washing, hence are durable finishes. Uses of an acrylic backing for upholstery fabric is an established practice. Acrylic dispersions have also found application as binders for nonwoven fabrics.

Coatings: Acrylic emulsion paints constitute a major expanding development. Specifically recommended for durability of finish, lack of odor, speed of drying, and ease of application, both the emulsion and compounded paints for interior and exterior use in pigmented formulations are available. Some formulations have been suggested for use over damp surfaces. Exterior use over masonry is an expanding application. Acrylic automotive finishes represent a promising field of application. Enhanced durability of the finish and prolonged retention of luster are achieved, particularly with the newer pastels. A thermosetting acrylic-base coating for appliances is also available.

For application by either spraying or brushing, acrylic-coating solutions in organic solvents are available in types that give almost any desired range of hardness or tackiness, with clarity and durability a prominent feature of all these coating materials. These acrylic coatings are for both decorative and protective uses, the scope of application ranging from protection of art treasures to resin treatment of raincoats. Decorative and metalized coatings can also be applied to plastics articles to enhance their appearance. Other coating applications include the use of water-soluble acrylic polymers in the thickening of resin-based coating formulations to a predetermined viscosity. In addition, such acrylic monomers as tetraethylene glycol dimethacrylate have found application in the preparation of coating and filling compositions and as vulcanizable plasticizers in plastisol formulations.

Paper: Acrylic dispersions are proving to be effective in the coating of paper. They are used for clear, greaseproof coatings, as binders for clay coatings, and as heat-sealing adhesives.

Adhesives: Acrylic monomers find application as components of copolymers used in making pressure-sensitive tapes and bonding agents. They impart improved aging characteristics and adhesion.

Leather: Acrylic dispersions are used in leather-finishing applications. As a base coat for cellulose nitrate and polyvinyl chloride finishes, the acrylics produce permanently flexible and strongly adhering coatings. When dry, these are no longer water dispersible but are soluble in the customary lacquer solvents so that excellent adhesion of subsequent lacquer coatings is obtained. An increasingly widespread use of acrylics in the leather field is as a component of water finishes. In such cases, the acrylic improves the adhesion, flexibility, and leveling of the finish, and depending upon the amount and type used, improves the washability. Improved dimensional stability of drying hides is achieved by the use of water-soluble acrylic pastes.

Soil stabilization: Acrylamide-methylene-bis-acrylamide compositions are being investigated for *in situ* polymerization in soils for such purposes as structural stabilization and impermeabilization.

Transparent gray-tinted protective shield molded of acrylic is placed over screen on television set. (Photo, Rohm & Haas)



References

Consult the Subject Index for additional information concerning acrylic resins. For specific information on injection molding, see p. 650. See also the Adhesives, Coatings, and Plastics Properties Charts for information on properties and trade designations. For sources of acrylics, see Directory Index, p. 1018.

"Accelerating effect of amines on polymerization of methyl methacrylate," by G. M. Brauer, R. M. Davenport, and W. C. Hansen, MODERN PLASTICS *34*, 153 (Nov. 1956).

"Stretched acrylic sheet—a new engineering material," MODERN PLASTICS *34*, 102 (Sept. 1956).

"Reinforced acrylic," MODERN PLASTICS *33*, 337 (June 1956).

"Extruded panels," MODERN PLASTICS *33*, 210 (May 1956).

"Plastic penthouse," MODERN PLASTICS *33*, 92 (Feb. 1956).

"Acrylic tanks," MODERN PLASTICS *33*, 196 (Feb. 1956).

"Stretching large-area acrylic sheet," by A. Batzdorff, Plastics Tech. *2*, 463 (July 1956).

"Investigation of the dynamic mechanical properties of polymethyl methacrylate," by B. Maxwell, J. Polymer Sci. *20*, 551 (June 1956).

"Characteristics of biaxially stretch-oriented acrylics," by D. A. Hurst, SPE J. *12*, 18 (May 1956).

"Effects of multiaxial stretching on crazing and other properties of transparent plastics," by I. Wolock and D. A. George, SPE J. *12*, 20 (Feb. 1956).

"Designing with transparent plastics," by A. M. Blumenfeld, SPE J. *12*, 28 (Feb. 1956).

"Sulfinic acid derivatives as accelerators in the polymerization of methyl methacrylate," by G. M. Brauer and F. R. Burns, J. Polymer Sci. *19*, 311 (Feb. 1956).

Amino Resins

BY HERBERT J. WEST*

RECENT DEVELOPMENTS

A urea-formaldehyde resin (*Uformite F-222,* Rohm & Haas Co.) for baking enamel formulations provides a white baking enamel with improved gloss, hardness, baking speed, and resistance to food stains. The resin also possesses improved adhesion with nondrying alkyds and improved water resistance.

Equipment for continuous production of urea-formaldehyde resin produces about 200 to 300 lb./hr. and is compact in size (W. H. Kreidl). The unit can be installed at the place of use, reducing the cost of the adhesive and eliminating the problem of aging.

A face coat (*Epocal,* Furane Plastics, Inc.) for expendable plaster or gypsum cement casts provides a much harder surface than gypsum cements and will not absorb water after setting. The material, a powdered melamine-urea composition containing fillers and curing agent, also reduces the problem of separating epoxy laminates or castings from the mold.

Triazine resin laminating sirups (*Cyzac,* American Cyanamid Co.) provide protective plastic surfaces on particle board or plywood. One resin (*Cyzac 2352*) is used with paper to provide durable flat working surfaces for tables, dressers, desks, and chests. Another resin (*Cyzac 2247*) is used on laminating papers in conjunction with the above resin to produce decorative surfaces for wood composition board that is to be used as wall paneling, door paneling, or in various "do-it-yourself" applications.

The two most important groups of amino resins are the urea-formaldehyde and melamine-formaldehyde resins. Both groups are thermosetting and cure to colorless, infusible solids, resistant to discoloration on aging or at elevated temperatures.

UREA-FORMALDEHYDE RESINS

Urea-formaldehyde resin sirups were first made, commercially, toward the end of the 1920's. The unmodified cured resins are clear colorless solids which resist discoloration on prolonged heating at moderate temperatures and on exposure to light. White translucent molding materials are made by compounding the resin with purified alpha-cellulose. Colored molding powder is made by the addition of appropriate pigments or dyes. In either of these forms, urea-formaldehyde resin sirups or dried powders have gained major importance in the manufacture of adhesives, in the treatment of textiles and paper, and in surface coatings.

The production of resins from urea and formaldehyde is based on the primary formation of methylol ureas by reaction of formaldehyde with the amide groups. (See Formula 1.) Two moles of formaldehyde may react to produce dimethylol urea.

The methylol ureas condense under slightly acid pH conditions with liberation of water to produce resinous products. The mechanism of the condensation is not positively established, but evidence indicates the formation of three-dimensional structures through methylene cross-linkage. (See Formula 2, p. 92.)

Marvel (J. Am. Chem. Soc. *68,* 1681, 1946) postulates a resin structure containing a network of hexahydro-triazine rings cross-linked by methylene groups. (See Formula 3, p. 92.)

The dimethylol compounds can react with alcohols in the presence of acids to form alkoxy compounds. These compounds condense with liberation of part of the combined alcohol to form resinous products soluble in organic solvents. These resins are used in surface coatings.

The basic resins are usually clear, water-white sirups or white powdered materials. The dry materials are usually dispersible in water to colorless sirups. Conversion to the insoluble and infusible stage occurs in the presence of acids or materials which develop acidity by reaction with formaldehyde. In most commercial applications the resin is cured by the application of heat. Certain formulations, however, particularly those used as adhesives, can be cured at room temperature by the use of an appropriate catalyst.

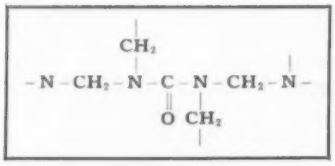
Molding compounds

Urea-formaldehyde resins may be compounded with cellulose filler, with or without pigmentation, to form the urea-formaldehyde molding compounds. Urea and formaldehyde solutions are first reacted to form an aqueous sirup. Purified alpha-cellulose is

$$NH_2-CO-NH_2 + HCHO \rightarrow NH_2-CO-NH-CH_2OH$$

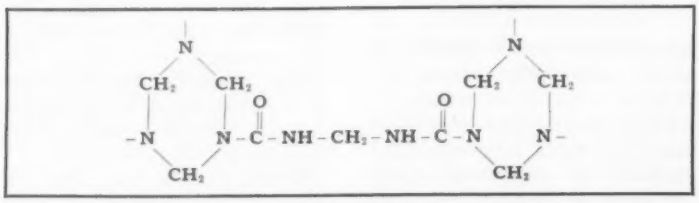
FORMULA 1

* Plastics and Resins Div., American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.
Recent Developments and References were prepared by the editors.



FORMULA 2

Formula 2 (left): Mechanism of condensation reaction used in production of urea involves formation of three-dimensional structures through methylene cross-linkage. Formula 3 (below): Network of hexahydrotriazine rings cross-linked by methylene groups. (See text, p. 91.)



FORMULA 3

added to the sirup and thoroughly mixed in. The white pulp obtained is dried under closely controlled conditions of heat and humidity. The dried material is ground to a fine powder.

At an appropriate stage in the operation, dyes or pigments, lubricants, and catalysts may be added. Usually as a final step in the operation, the powdered material is densified by one of several available methods and the densified product crushed to give the finished molding material in the form of granules.

The unpigmented material gives translucent pearl-white moldings. Colored material gives opaque-to-translucent pastel or full shades, depending upon the type of pigment or dye used.

The molding compounds are usually available in a range of plasticities from very soft to hard. The rate of cure can be controlled during manufacture. Consequently, the molder can usually select a grade of molding material suitable for any specific molding condition. Low-cost grades are available for dark-colored industrial moldings such as electrical parts.

The materials are usually molded within the temperature range of 275 to 350° F. and at pressures ranging from 2000 to 8000 p.s.i. They are more critical to mold than either the phenolics or the melamine-formaldehyde molding compounds. They do not flow quite as readily, and generally set and cure faster in the mold. Both mold-shrinkage and aging-shrinkage values are greater with ureas than with the phenolics.

Largely because of unlimited color possibilities, solvent-, oil-, and grease-resistance, surface hardness, mar-resistance, and so forth, urea-formaldehyde molding compounds are widely used in such applications as cosmetic container closures, buttons, electric mixer housings, and stove hardware.

School desk surfaced with melamine-impregnated decorative laminate can be easily wiped clean of crayon marks. (Photo, American Cyanamid)



Adhesives

Urea-formaldehyde resins have gained wide acceptance for use as adhesives in the plywood and furniture industries. These adhesives can be formulated to cure over a wide range of temperatures. They tolerate a high degree of extension with relatively low-cost material, such as wheat-flour, without serious impairment of the properties of the glue-line.

The resins used as adhesives are usually formulated at a ratio of less than 2 moles formaldehyde to 1 mole of urea.

Urea adhesives cure rapidly at the elevated temperatures used in hot-press operations. When the proper catalysts, as recommended by the manufacturer, are used, excellent bonds are obtained at room temperatures.

Textile and paper resins

Low-molecular-weight urea-formaldehyde condensation products are useful for the impregnation of cotton or rayon textile fabrics to develop improved creaseproofness and other valuable properties. The resin, containing an appropriate catalyst, is cured in the cloth by heating the impregnated goods at temperatures ranging usually from 200 to 250° F. Other types, usually of higher molecular weight, are employed in the various stiffening processes.

Urea-formaldehyde condensation products may be modified to give cationic resin molecules substantive to negatively charged

Applications of amino resins in various forms

Urea-formaldehyde resins

Type of product

Molding compounds	*Adhesives*	*Textile resins*	*Paper resins*	*Surface coatings*
Forms available				
Powder; Granules	*Powder; Water solutions*	*Powder; Water solutions*	*Powder; Water solutions*	*Solutions in organic solvents*
Uses				
Radio cabinets Stove hardware Closures Cosmetic containers Electric mixer housings Wiring devices	Plywood Furniture panels and assembly Lumber core gluing and laminating Doors Sporting goods V-board Bag seams Particle board binders	Textile treatments such as: Fabric stiffening Wrinkle control Control of fabric "hand"	Wet strength	Marproof finishes for interior use Refrigerators Kitchen cabinets Medicine chests Toys

Melamine-formaldehyde resins

Type of product

Molding compounds		*Adhesives*	*Textile resins*	*Paper resins*	*Surface coatings*	*Laminating resins*
Forms available						
Powder; Granules		*White and tan free-flowing powders*	*White free-flowing powders; Aqueous solutions*	*White free-flowing powder*	*Solutions in organic solvents*	*Powder; Aqueous solutions*
Uses						
Dinnerware Closures Boil-resistant buttons Aerosol and cosmetic containers Stove fixtures Surgical instrument parts Pen and pencil sets Housings: industrial and consumer	Syrup dispensers Auto and aircraft ignition parts Radio, T.V., and other electronic parts Meter blocks Electrical components, e.g., switch gear, coil forms, etc.	Exterior- and marine-grade plywood Reinforcement of urea adhesives Gypsum reinforcement	Draping control Wool shrinkage control Durable stiffening Fire retardance Water repellence	Wet strength Improved fold and dry strength Dimensional stability	Marproof exterior baked finishes of excellent durability	Mar-resistant decorative laminates Fire- and shock-resistant laminates with excellent electrical properties

cellulose fiber. When added in the beater on a paper machine, the resin is almost quantitatively absorbed by the fiber and confers a high degree of wet strength to the finished paper sheet.

Surface coatings

Alkylated urea-formaldehyde resins were first produced commercially in this country in 1936. Their use in surface coatings represented a big advance in the technology of synthetic baking enamels. When used as hardeners with suitable alkyd resins, these solvent-soluble urea resins permit the formulation of enamels that can be baked to almost porcelain-like hardness. These new resins rapidly achieved commercial importance in the production of a wide range of synthetic baking enamels, particularly white enamel for refrigerators and kitchen and hospital furnishings. The finishes are resistant to water, soap, and mild acids, and are characterized by excellent color retention.

Urea-formaldehyde compound enamels are usually cured at temperatures of 250° F. or above, although formulations are available for cure at room temperature or under forced-dry conditions.

MELAMINE-FORMALDEHYDE RESINS

The most striking feature of melamine-formaldehyde resins is their unusual versatility. Perhaps no other thermosetting materials have as many diverse and valuable applications.

Melamine resins were first introduced to industry in the late 1930's. Today, materials produced from melamine are used in a wide range of important applications, such as critical military parts, industrial and decorative household appliances, high-grade dinnerware and tableware, shockproof laminates for use in naval craft, and decorative laminates for the household and office. They are used in durable boilproof adhesives, in leather tanning, in the treatment of textiles, in the production of wet-strength paper, and in the manufacture of enamel finishes with a high degree of exterior durability.

Chemistry

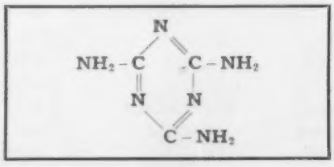
Melamine may be considered as the cyclic trimer of cyanamide. (See Formula 4.) It is shipped as a white, free-flowing powder and has the following characteristics: Melting point—354° C. (approximately); density—1.57; solubility in water at 25° C.—0.5 percent.

Melamine reacts with 1 to 6 molecules of formaldehyde to form methylol compounds. Hexamethylol melamine can be isolated as a pure crystalline compound with the structure shown in Formula 5.

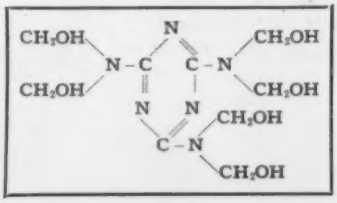
These methylol compounds can condense to resinous products by mechanisms which are probably similar to those involved in the condensation of methylol ureas. Three-dimensional structures are created with the triazine rings probably cross-linked by methylene groups.

The molding compounds are produced from methylol derivatives containing a relatively low ratio of formaldehyde to melamine.

The cure of the resins is accelerated by acids although it can be accomplished by heat alone under neutral or even slightly alkaline pH conditions. The cured resins are resistant to mild acids, mild alkalies, and boiling water. They are tasteless, odorless, and colorless, and do not discolor on exposure to relatively high temperatures or sunlight. Electrical properties are excellent, particularly arc resistance.



FORMULA 4



FORMULA 5

The methylol melamine compounds behave somewhat like the methylol ureas when reacted with alcohols under mildly acid conditions, forming alkoxymethyl melamines. The methoxy compounds or methyl ethers, as they are sometimes described, are generally water-soluble, whereas the ethyl and higher alcohol derivatives show decreased solubility in water but are soluble in organic solvents.

Molding compounds

Melamine-formaldehyde condensation products are processed into molding compounds by methods similar to those used in the manufacture of the ureas. As with the latter materials, dyes or pigments may be incorporated to produce opaque or translucent colored material. The moldings are similar in appearance to ureas but possess unusual heat resistance and mar resistance. These latter properties have widely extended the range of their application.

The molding of fine-quality dinnerware is the most successful and spectacular use for alpha cellulose-filled melamine-formaldehyde molding compounds. This application now represents by far the largest single outlet for the melamines. The attractiveness of melamine dinnerware can be enhanced by the use of decorative overlays which are now available in a wide range of colors and designs.

Other important uses for the melamines are in aerosol dispensers, boil-resistant buttons, coffee makers, soda dispensers, flatware, and cutlery handles.

The alpha-filled melamines are available in different degrees of plasticity, but the bulk of the material is sold in a soft plasticity suitable for transfer or plunger molding. All grades are suitable for preheating by high-frequency methods.

Fillers

The properties of melamine molding compounds vary widely according to the kind of filler

that is used in it. For example, wood flour may be used for the production of general-purpose industrial molding compounds for the molding of parts such as auto ignition components, connector plug inserts, and watt-meter blocks. The parts possess high arc resistance and dielectric strength, combined with relatively low specific gravity.

Cotton fabric may be used as a filler for molding material intended for the production of shock-resistant articles such as service trays.

Mineral fillers such as asbestos may be used for molding compounds intended for industrial applications requiring maximum arc- and heat-resistance and dielectric strength. The properties of such parts are maintained up to temperatures that can go as high as 400° F.

Glass fiber-filled material is available for applications requiring a combination of impact strength, high heat resistance, and good electrical properties, including maximum arc resistance.

Laminating

Melamine resins are widely used in laminated products. Sheets of paper, glass cloth, or other fabric are impregnated with the resin solution and dried to a controlled moisture content. Several plies of the impregnated sheets are laminated in a platen press and cured at temperatures of 290 to 320° F. for 15 to 30 min., at pressures ranging from 1000 to 2000 p.s.i. This type of application has enjoyed its greatest success in decorative and durable laminates for tabletops and similar applications.

Adhesives

Certain melamine resins can produce excellent bonds between a variety of surfaces when heat-set. Commercial formulations, however, are usually melamine-fortified urea adhesives. In contrast to urea-formaldehyde adhesives, the available melamine-urea types presently cannot be cold-set.

An unusual property of melamine adhesives or melamine-fortified urea resin adhesives is the stability of the dried adhesive after application to the surface to be glued. The applied adhesive is stable for weeks if kept at room temperature, but it cures very rapidly when heat is applied to it.



Stylish housing for intercommunication set for household use is molded of rugged urea in one piece. (Photo, Barrett Div., Allied Chemical & Dye)

Textile processing

Melamine resins have gained wide acceptance for the treatment of rayon, cotton, wool, and other fabrics to impart properties such as shrink resistance, water and stain repellency, wrinkle resistance, and fire retardance. The melamine resin is usually applied to the goods from a water solution. The goods are dried at a temperature high enough to cure the resin, and finally washed to remove excess accelerator and any of the uncured resin that may remain.

Paper treatment

Melamine-formaldehyde condensation products, particularly those made with the lower formaldehyde/melamine ratios, have found extensive use in improving the properties of paper and imparting wet strength to it. Under certain acidic conditions, methylol melamines can react to give cationic colloids that exhaust quantitatively on the negatively charged paper fiber. The resin is usually added to the slush stock. The resin cures during the drying of the sheet, producing remarkable improvements in the physical properties of the paper. Wet strength is increased severalfold and dry strength improved by the addition of the resin.

Surface coatings

The alkylated methylol melamines, especially the butylated types, are used in combination with alkyd resins for the production of high-quality industrial baking finishes. Their behavior is similar to that of the corresponding urea resins, but the melamines are more effective hardeners for the enamel film. They develop improved mar resistance and increased water and alkali resistance. Initial color is at least equal to that obtained with the ureas and color retention is much better at elevated temperatures. Melamine-resin-fortified alkyd resins have unusual exterior durability.

Melamine is also used for plaster reinforcement, ion exchange resins, and leather tanning.

References

Consult the Subject Index for additional information concerning urea and melamine resins. For information on compression molding, see p. 680. See also the Adhesives, Coatings, Foamed Plastics, Laminates, and Plastics Properties Charts for information on properties and trade designations. For sources of amino resins, see Directory Index, p. 1018.

"Case history of a terminal block," MODERN PLASTICS *32*, 125 (Nov. 1954).

"Success story: melamine dinnerware," MODERN PLASTICS *31*, 166 (June 1954).

"Infra-red analysis of paint vehicles based on alkyd-nitrogen resin blends," by C. D. Miller and O. D. Shreve, Analytical Chem. *28*, 200 (Feb. 1956).

"Reaction and cure in melamine plastics," by H. P. Wohnsiedler, I. H. Updegraff, and R. H. Hunt, Jr., Ind. Eng. Chem. *48*, 82 (Jan. 1956).

"Reaction of cellulose with dimethylol and monomethylolureas," by R. Steele and L. E. Giddings, Jr., Ind. Eng. Chem. *48*, 110 (Jan. 1956).

"Catalysis of urea-formaldehyde condensation," by I. J. Gruntfest and E. M. Yound, Jr., Ind. Eng. Chem. *48*, 107 (Jan. 1956).

Cellulosics

RECENT DEVELOPMENTS

A lacquer for coating and decorating cellulose acetate (*Rez-N-Lac A*, Schwartz Chemical Co., Inc.) has a nontoxic resin base, permitting use of the lacquer on children's toys and other objects that come in contact with the body. The lacquer will not flake or craze nor become brittle.

Cellulose acetate film (*S-652*, Celanese Corp. of America) is used by merchants for wrapping food and produce before it is put on the shelf. The acetate stays crisp and breathes, preventing foggy-looking packages. It is furnished in bundles of 1000 units in sizes ranging from 10 by 10 to 20 by 20 in., and can be sealed easily with plates or hand irons with polytetrafluoroethylene-impregnated fibrous glass pads.

A quick-drying lacquer (*Rez-N-Lac B*, Schwartz Chemical Co., Inc.) for coating and decorating butyrate has permanent adhesion and low flammability. The lacquer can be applied by brush or spray. It is nontoxic and waterproof, and does not flake or craze.

Oldest of the synthetic plastics is cellulose nitrate, dating back to the work of Braconnot in France, 1833. Schoenbein, Germany, 1845, and Parkes, England, 1855-65, also experimented with cellulose nitrate; but John Wesley Hyatt, United States, is generally credited with being the first to work successfully with this material as a plastic mass rather than in solution. In 1869 he and his brother took out a patent for making solid collodion (Celluloid) which was the pioneer material for many processes and applications used in the plastics industry.

Meanwhile, in an effort to discover a less flammable material, research conducted by Schützenberger and Cross and Bevan (1894) led toward the development of cellulose acetate plastic. Preparation of a plastic from cellulose acetate was first mentioned in United States patent literature in 1903.[1]

As early as 1912, cellulose acetate found outlet in photographic film. In World War I, it was employed in dopes for airfoil coverings. Later, a process was developed for making cellulose acetate filament which could be woven into fabric.[2] Cellulose acetate sheets, rods, and tubes appeared on the U. S. market in 1927. This was followed by the appearance of cellulose acetate molding powders in 1929.

Research on treatment of cellulose with higher aliphatic acids resulted in a U. S. patent for the manufacture of cellulose acetate butyrate, issued to Clarke and Malm in 1932. The material appeared on the market at that time for use in protective coatings. The molding composition followed in 1938.

Among the cellulose esters, cellulose propionate is the most recent commercial plastic. A patent covering the preparation of cellulose propionate was issued in 1931; but it remained a laboratory plastic until 1945, when a process was developed for economically producing propionic acid from natural gas.

The possibility of using a cellulose ether as an industrially useful product was proposed in 1912 by Leuchs in Germany, Lilienfeld in Austria, and Dreyfus in France. Lilienfeld was granted a U. S. patent[3] in 1917 for use of ethyl cellulose in a plastic composition. In 1935 and 1937, respectively, two of the current manufacturers[4] undertook commercial production of this material.

Other cellulose ethers have also proved commercially useful; among these are methyl cellulose, carboxymethyl cellulose, and hydroxyethyl cellulose.

During the earlier development of cellulose plastics, research was conducted also on the conversion of solid cellulose into liquid chemical compounds, and the subsequent regeneration of the cellulose in the form of films (cellophane) and filaments (rayon).

The cellulosics are prepared by various treatments of carefully purified cotton linters or wood cellulose having a high alpha-cellulose content. The cellulose molecule is composed of as many as 3000 glucosidic units. Each unit provides three hydroxyl groups for esterification. Controlling factors in the preparation of the various cellulose esters and ethers are the condition of the cellulose, the kind and relative amounts of ingredients used, and the time, temperature, and agitation of reaction.

Cellulose nitrate: Cellulose nitrate is prepared by treating properly conditioned cellulose with a mixture of nitric and sulfuric acids. Spent acid is drained off by centrifuging. The nitrated material is given prolonged treatment with boiling water, bleached, washed repeatedly, and subjected to a dehydrating operation by which, under hydraulic pressure, most of the water is replaced by alcohol.

Cellulose acetate: Preparation of cellulose acetate is accomplished by treating cellulose with acetic acid and acetic anhydride in the presence of a catalyst such as sulfuric acid. Cellulose triacetate of about 62.5% combined acetic acid content is formed by the reaction. This is soluble in the treating acids, forming a heavy dope. Water is added to partially hydrolyze or deacetylate the cellulose triacetate. Cellulose acetate is then precipitated in water, washed, and dried.

Cellulose acetate butyrate: To prepare cellulose acetate buty-

[1] U. S. Patent 738,533 to A. Eichengrün and T. Becker, 1903.

[2] Developed by Celanese Corp of America.

[3] U. S. Patent 1,217,027.

[4] Hercules Powder Co., The Dow Chemical Co.

rate, the cellulose is treated with a mixture of acetic and butyric acids and anhydrides, the amount of each ingredient depending upon the properties which it is desirable to have in the final product.

Cellulose propionate: Similarly, the reaction of propionic acid and anhydride on cellulose in the presence of a catalyst yields cellulose propionate.

Ethyl cellulose: Sodium cellulose is produced by the action of a strong alkali, such as sodium hydroxide, on cellulose. This is subsequently acted upon by ethylating agents such as ethyl chloride or sulfate which place the ethyl groups on the cellulose molecule. Ethyl cellulose thus formed is first washed and then purified.

Carboxymethyl cellulose: Carboxymethyl cellulose (cellulose glycolate) is composed of a carboxylic acid bound to the cellulose molecule by an ether linkage. Upon treatment with a fairly strong acid, the sodium salt is converted to the free acid which is insoluble in water. In some cases other salts may be useful; the ammonium salt, on heating, loses ammonia and is thus converted to the free acid; the addition of aluminum, iron, or other heavy metal ions converts the sodium salt to insoluble compounds. The cellulose derivative is precipitated from solution by ferric chloride, ferrous sulfate, stannous chloride, aluminum sulfate, or basic lead acetate. Barium nitrate produces a thixotropic gel.

Hydroxyethyl cellulose: When ethylene oxide is reacted with cellulose, a caustic-soluble hydroxyethyl cellulose is first produced. As additional hydroxyethyl groups are attached, the cellulose derivative becomes more and more water sensitive, until water solubility is reached. Metallic ions, acids, or alkalies cannot be used to precipitate hydroxyethyl cellulose from the aqueous solution.

Regenerated cellulose (cellophane): For the preparation of regenerated cellulose, sheets of sulfite wood are steeped in a carefully controlled solution of sodium hydroxide, resulting in a product known as sodium or alkali cellulose. Excess liquor is removed, and the alkali cellulose sheets are shredded and aged. Treatment with carbon disulfide follows, producing cellulose xanthate. This, in turn, is mixed with dilute sodium hydroxide solution to yield a uniform colloidal suspension, or viscose, which is aged and filtered. Regeneration is accomplished by extruding the viscose, in sheet form, into an acid coagulating bath which reacts with the viscose solution to form cellulose, sodium sulfate, and carbon disulfide.

Cellulose nitrate

Compounding and processing: Several grades of cellulose nitrate are available, differing in nitrogen content as well as in the degree of viscosity.

Complete esterification provides a nitrogen content of 14.16 percent. Cellulose nitrate used in explosives contains approximately 13%, that employed in lacquers and photographic film about 12%, and that in plastics about 11 percent. Although the chief difference among the various grades is their rate of combustion, solubility as well as compatibility with plasticizers are also variable factors that have to be taken into consideration.

Camphor is the standard plasticizer for cellulose nitrate, although small admixtures of other materials are also used. Alcohol-wet cellulose nitrate is colloided in masticating mixers with the plasticizers and solvents, and strained under hydraulic pressure while in a soft condition. The material can be colored while being worked in the mixer or during the subsequent rolling operation, when some solvent has been evaporated.

Plastic slabs from the rolls can be block-pressed and skived, or the mass containing a suitable proportion of solvent may be wet-extruded into tubes, rods, or sheeting.

General characteristics: Cellulose nitrate is the toughest of all thermoplastics. This quality and ease of fabrication are the chief advantages of the material. Other desirable properties of cellulose nitrate are its dimensional stability, resilience, and low water absorption.

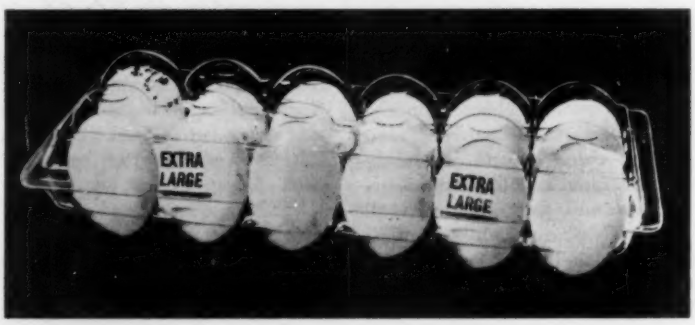
Chief disadvantage of the material is its flammability. Plasticizers containing chlorine and phosphate as fire retardants have been employed, but these tend to reduce the strength of the resulting plastic. Another disadvantage of the material is its tendency to discolor and become brittle under the effects of sunlight.

Cellulose nitrate is not adaptable for compression or injection molding because of its sensitivity to heat. However, it is readily formed into hollow articles by application of air or liquid pressure between heated sheets, expanding them to the shape of a retaining mold. By other methods of fabrication, sheets, rods, and tubes are converted into many items of decorative and functional value, such as personal accessories, toilet articles, and various types of industrial pieces.

Cellulose acetate

Compounding and processing: Cellulose acetate molding compositions are made from cellulose

Egg carton vacuum formed of clear cellulose acetate sheeting allows shoppers to see eggs, is reusable. (Photo, Celanese Corp. of America)





All parts of telephone base, including housing, pushbuttons, and transparent escutcheon, are molded of tough cellulose acetate. (Photo, Hercules Powder)

acetate flake, plasticizers, pigments, and dyes. In the manufacture of cellulose acetate molding and extrusion compounds, the flake is mixed with suitable plasticizers and colorants. Mixing is carried out on heated compounding rolls, in an extruder, or in a Banbury-type mechanical mixer. Processing temperatures are in the 350 to 500° F. range. Plasticizers used are normally simple organic esters, liquids of high boiling point and low vapor pressure, added in amounts of 10 to 70 parts per 100 parts of cellulose acetate. The plasticizer employed is dependent upon the properties desired in the finished composition. After mixing and colloiding, the material is cut into granules or pellets of the desired size and shape for use in injection molding or extrusion.

General characteristics: Cellulose acetate plastics are notable for their outstanding toughness and high impact strength. They are stable at room temperatures, with excellent resistance to discoloration or deterioration induced by sunlight. Materials can be produced over a wide range of rich lustrous colors, including translucents, transparents, and special color effects. Cellulose acetate is a good electrical insulator, and the clear material makes possible a high percentage of transmission of ultra-violet light.

Available in many different types, cellulose acetate is adaptable to a wide application range. The properties of the material are dependent to a large degree on the flow type selected. High-acetyl materials (hard-flow acetates with a combined acetic acid content in the 56 to 58% range) provide increased moisture resistance and, as a result, greater dimensional stability as well as improved dielectric properties. The medium- and soft-flow materials meeting most general-purpose requirements are compositions based on flake of lower acetic acid content ranging downward from 55 percent.

Present-day uses of cellulose acetate have been further broadened by the increasing trend towards formulating for specific end uses. Selection of the proper flake, combined with suitable plasticizers, yields compositions with the characteristics important to specific applications. The important properties that can be "built in" to cellulose acetate include flame resistance, resistance to blushing, improved dimensional stability, reduced plasticizer migration, inertness to other plastics such as acrylics and styrenes, and resistance to specific chemicals, e.g., dichlorobenzene.

Applications: Large-volume markets for cellulose acetate are toys, beads, cutlery handles, knobs, electrical parts, and housings for small-motored electrical appliances. In sheet form, cellulose acetate is widely used as a packaging material, electric insulation, and tape. Vacuum formed sheeting is in growing use in the fabrication of displays, custom-packaging, and small household and personal products.

Newest large-volume application for acetate is ladies' shoe heels. The molded acetate heels are claimed to cost from 2 to 4¢ less than wooden heels with lacquer applied and are characterized by resilience and toughness. Consumption of acetate for heels was estimated at least as high as 500,000 lb. a month by the end of 1956.

Cellulose acetate butyrate

Compounding and processing: Cellulose acetate butyrate requires less plasticizer than does cellulose acetate. In general, the mixed ester has greater solubility in a wider range of solvents and is compatible with a greater number of plasticizers. Pigments and dyes give translucency and color.

Cellulose acetate butyrate plastics are ordinarily shaped by injection molding and continuous extrusion. The material can be injection molded at the highest speeds possible with plastics. Large, intricately shaped articles can be molded in single molds. Compared to cellulose acetate, cellulose acetate butyrate requires less pressure in molding than is indicated by flow designation. To a certain point, flow increases uniformly with temperature, but the material flows considerably faster beyond this critical point. Thus it is possible to obtain grades which, below molding temperature, have relatively high resistance to heat, but flow at molding temperature.

The material is suitable for continuous extrusion under heat and pressure without the use of solvents. Extruded sections can have close tolerances.

General characteristics: The primary physical properties of cellulose acetate butyrate are a horn-like toughness, high impact strength, uniform texture, dimensional stability under normally varying conditions of temperature and humidity, and low moisture absorption. The material is resili-

Colorful portable transistor radio case is molded of rugged cellulose propionate, will not break even if accidentally dropped. (Photo, Celanese Corp.)



ent, light in weight, and has a high surface luster, dielectric strength, and low heat conductivity. It is available in more than 19,000 colors and color effects. Clarity ranges from transparent through translucent to opaque. Variegated, metallic, fluorescent, and pearl effects may be produced.

Like cellulose acetate, cellulose acetate butyrate is easily fabricated and machined with tools used for wood and metal. Molded and extruded pieces can be cemented in a bond as strong as the material itself. Cellulose acetate butyrate is not compatible with cellulose acetate.

Melt-coating compositions of cellulose acetate butyrate are used to produce a brilliant, flexible, waterproof finish on paper and fabric. The same compositions mixed with oil make continuous, tough, transparent coatings, easily cut and stripped, for the protection of metal tools and parts for shipment.

When extruded over rigid metal, cellulose acetate butyrate provides a surface that is tough, chip-proof, and resistant to perspiration, grease, and other contaminants.

An economical and quick method for fastening fabric wall-covering panels in place is also provided by cellulose acetate butyrate strips. These assemblies are employed in airplane interiors, where the light weight of butyrate is an advantage.

Pipe extruded from cellulose acetate butyrate is being used for irrigation, salt water disposal, gas service lines, and as electrical conduit for telephone and power cables.

There is increased interest in extruded sheeting for use as explosion-vent windows, and indoor and outdoor signs made by vacuum forming from heavy-gage sheeting up to 0.125 in. thick.

Cellulose acetate butyrate film is used as primary insulation on solid and stranded wire and cable, permitting an important reduction in wire diameter and saving weight.



Pipe made of cellulose acetate butyrate is used as power cable conduit. Material combines high-impact strength with dielectric strength. (Photo, Eastman)

Cellulose propionate

Compounding and processing: Cellulose propionate requires less than half the plasticizer needed to produce cellulose acetate butyrate plastics of comparable flexural strength. It is compatible with a considerably larger number of plasticizers; compounds can therefore be plasticized and modified to produce moldings of a great variety of properties.

Cellulose propionate is best suited to injection molding and extrusion. It has excellent flow characteristics which provide noncritical molding temperatures over a range of 80° F. Unless inserts, machine limitations, heavy cross-sections, or ribbings are involved, it has a shorter cycle than other cellulosics. In all except the hardest compositions there is no trace of skin or laminations.

General characteristics: Cellulose propionate is an unusually stable cellulose ester, emitting no odor of propionic acid either during molding or in the finished piece. Retention of plasticizer is excellent. Weatherability characteristics are superior to cellulose acetate while being equivalent and, in some instances, superior to other cellulosic molding materials. Although not miscible with cellulose acetate, ethyl cellulose, or resinous plastics such as polystyrene, cellulose propionate is compatible with cellulose acetate butyrate.

Among the cellulosics, cellulose propionate is close to ethyl cellulose in toughness and shock resistance. High shock resistance is maintained without sacrifice of other desirable characteristics. Articles produced from cellulose propionate can be printed and lacquered without fear of tackiness. Weld lines are almost unnoticeable, and weld strength is high as indicated by both impact and tensile strength tests. Surface finish of injection molded pieces is brilliant and so lustrous and free from smudges that many parts require no buffing or similar finishing operation.

Applications: Current markets for cellulose propionate are automotive parts, pens and pencils, telephone housings, ladies' shoe heels, toys, radio and television parts, toothbrushes, and sunglass frames. Special formulations are also available for potable water applications.

Ethyl cellulose

Compounding and processing: The purified white granular ethyl cellulose is mixed with plasticizers and colored to give molding material. Many modifiers are available for ethyl cellulose formulations.

On standard compression molding equipment, temperatures in the range of 350 to 380° F. are required, and pressures of 2000 to 4000 p.s.i. Injection molding temperatures of 375 to 430° F. with

pressures of 8000 to 20,000 p.s.i. are common practice. Extrusion by the dry method can be accomplished at temperatures approximating those of injection molding. Casting hollow articles of ethyl cellulose is readily accomplished.

Sheets can be drawn or swaged. Thicknesses up to 0.125 in. have been fabricated by drawing. Machining can be done with the same equipment used for other cellulosics or for wood.

Lacquers can be formulated for brushing, spraying or dipping, and formulas are available for hot-melt coating of paper and cloth.

General characteristics: A number of different grades of ethyl cellulose are commercially available. The more completely ethylated product, 48 to 49.5%, has better compatibility with waxes, resins, and other modifiers. Generally, this type of ethyl cellulose product has good water resistance, wide solubility, and a lower softening point than the lower ethylated products. The ethyl cellulose with an ethoxyl content of 46 to 48% gives a tough material with excellent low-temperature characteristics. The viscosity of the ethyl cellulose flake also can be varied and, in general, the higher the value the greater the strength and toughness of the end product.

The low water absorption and chemical stability of ethyl cellulose have resulted in compositions possessing excellent dimensional stability over a wide range of temperatures and humidities. High-impact strength at normal and sub-zero temperatures is characteristic of ethyl cellulose. Electrically, ethyl cellulose is usually superior to other cellulose derivatives.

Ethyl cellulose is the lightest of the cellulose products now on the market. With a density of 1.07 to 1.18, it has great value in those applications in which the factor of weight is important.

In addition to plasticizers and solvents, many compounds in the field of esters, natural resins, resin acids, resin esters, tars, and waxes can be used with ethyl cellulose. It is also compatible with cellulose nitrate, but not with cellulose acetate nor with butyrate.

Advantage is taken of the strength characteristics, moisture resistance, and dimensional stability of ethyl cellulose in the production of items which must inevitably be subjected to abuse. Ethyl cellulose is useful in a chemical-resistant insulating and waterproofing material which can be employed as a sealing or potting compound with high resistance to electric current.

Cast ethyl cellulose dies and jigs have provided a quick and relatively inexpensive means to meet tooling demands. The casting compound retains its toughness, dimensional stability, and other properties under varying conditions of application. The product can be reused without processing.

Flexible films of ethyl cellulose are serviceable as moisture barriers. As strip coatings, they provide an easy method of preventing corrosion and damage on metal parts in transit or in storage.



Outdoor sign, 25 by 40 ft., is made of corrugated sheet (see close-up), extruded of weather-resistant cellulose acetate butyrate. Continuous extrusions 40 ft. long eliminated problem of assembling smaller units. All decorating on the sign face is done by overlay butyrate sheet in various colors. (Photo, Eastman Chemical)

Carboxymethyl cellulose

Compounding and processing: This cellulose derivative is compatible in varying proportions with many water-soluble plasticizers, natural gums, and other film formers. Highly viscous, stable aqueous solutions can be obtained which, upon evaporation, leave colorless, tough, transparent films that are unaffected by most organic solvents, oils, and greases.

General characteristics: Carboxymethyl cellulose is available in three viscosity types: low, medium, and high. These products can be rapidly dissolved in water-ethanol mixtures, when the alcohol does not exceed 50% of the mixture. Films cast from sodium carboxymethyl cellulose solutions and painted with solutions of

aluminum sulfate, barium nitrate, stannous chloride, basic lead acetate, ferric chloride, or ferrous sulfate are insoluble in water. The solutions of sodium carboxymethyl cellulose are commonly utilized for their thickening properties as viscosity control agents in the preparation of latex emulsions, as emulsifying agents in the preparation of oil-in-water solutions, and as bases for ointments, boiler compounds, oil-drilling muds, and insecticides. Other applications for this cellulose derivative are as coatings for carton board used in the manufacture of containers which must be greaseproof.

Hydroxyethyl cellulose

As well as resembling other commercial cellulose derivatives, hydroxyethyl cellulose, in many respects, resembles the water-soluble or water-dispersible alginates, natural gums, and starches. Some advantages it exhibits over these materials are uniformity, complete solubility in water at all temperatures, and stability of solutions. A low-viscosity solution of hydroxyethyl cellulose is comparable in consistency to gum arabic.

Hydroxyethyl cellulose *dry powder* is a free-flowing white to light tan powder available in several types that yield solutions of different viscosities. In the dry form it can be esterified or etherified more easily than cellulose. Dry hydroxyethyl cellulose does not melt but decomposes gradually at temperatures above 300° F., especially in the presence of acids, alkalies, or salts, behaving in this respect much like other cellulose materials such as paper or cotton. It begins to char at about 400° F., while long exposure at slightly lower temperatures, especially in the presence of acidic materials, causes browning or embrittling. The powdered material retains its hygroscopicity after application and remains free-flowing even when it contains 25% water.

Hydroxyethyl cellulose *aqueous solutions*, in general, are insoluble in most organic solvents. They are compatible with gelatin, gum arabic, gum tragacanth, British gum, and other water-soluble film-forming materials. Mineral acids hydrolyze hydroxyethyl cellulose, while strong alkalies cause an initial decrease in the viscosity.



Molded women's shoe heels represent large-volume market for cellulose acetate. Resilient, tough, and low in cost, heels can be used plain or covered. (Photo, Celanese)

On drying, a hydroxyethyl cellulose solution deposits a clear, cellophane-like film that is colorless, odorless, tasteless, soluble in water, and stable to heat and light. The flexibility of these films is greatly increased by adding one of several polyhydric alcohols such as triethylene glycol, a polyethylene glycol, a polypropylene glycol, or glycerol. The films are rendered resistant to water by the addition of glyoxal to the solution, or by reacting the hydroxyethyl cellulose with urea and formaldehyde.

Cellophane

Compounding and processing: The film, prepared by regeneration of cellulose from viscose solution, is immersed in successive purification baths, and finally in dilute solutions of glycerol or other softening agents which may also flameproof the film. The film is then dried to the desired moisture content and sheeted or slit into small rolls. If moistureproof film is desired, a coating composition is applied in very thin layers on both sides of the cellophane.

General characteristics: Commercially, cellophane is the most widely available and least expensive film. It is easily fabricated, and especially adaptable to high-speed automatic machinery and to various printing techniques. Cellophane is suitable for a great many decorative purposes.

Electrical properties of the material permit its use in industrial electrical equipment. The film serves not only as insulation but also as a protection against oil and grease. It is employed in low-pressure molding of laminates to prevent the material from sticking to the mold, and sometimes as the agent upon which plastics are cast.

By itself or laminated to itself, to metal foils, or to various types of paper, cellophane affords excellent protection for fresh and frozen foods, tobacco, textiles, and medical supplies, as well as for metal items.

References

Consult the Subject Index for additional information on cellulosic plastics. For injection molding, see p. 650; for extrusion, see p. 680; for fabricating, see p 818. See also the Adhesives, Coatings, Films, Foamed Plastics, and Plastics Properties Charts for information on properties and trade names. For sources of cellulosics, see Directory Index, p. 1018.

"Records by the millions," MODERN PLASTICS *34*, 152 (Oct. 1956).

"Why frames of extruded acetate?" MODERN PLASTICS *33*, 106 (May 1956).

"Illusion of motion in plastics," MODERN PLASTICS *33*, 110 (May 1956).

"Cellulose propionate molding compounds," by D. A. Jones, SPE J. *12*, 36 (Aug. 1956).

"Weathering of ethyl cellulose plastic," by M. Chamberlain, R. A. DeLap, and C. L. Stacy, Ind. Eng. Chem. *48*, 1209 (July 1956).

"Properties and applications of butyrate pipe," by L. W. A. Meyer and R. J. Scogin, Plastics Tech. *2*, 382 (June 1956).

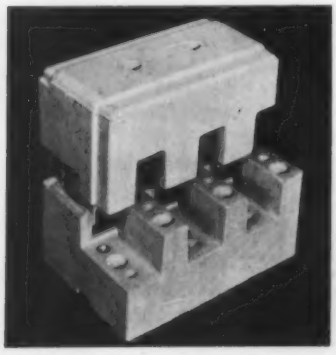
"Thermal degradation of wood and cellulose," by A. J. Stamm, Ind. Eng. Chem. *48*, 413 (Mar. 1956).

"A new polymer-coated cellophane," by E. Hartshorne and L. E. Simerl, Modern Packaging *29*, 139 (Jan. 1956).

Cold Molded Organic Plastics

Cold molded plastics were introduced in the United States near the beginning of this century by Emile Hemming. They differ basically from the more common plastics molding materials in that they must be baked after removal from the mold to oxidize and polymerize the binder materials. Cold molded plastics fall into two main categories based on the types of binders employed—organic, and inorganic or refractory. The organic materials are divided into two types—bituminous (asphaltic, binder) and synthetic resin (phenolic binder). Inorganic cold molded materials are discussed in the chapter on Inorganic Plastics. Asbestos is a common filler for all types and the high-heat resistance characteristic of these materials is due to the asbestos in the formula.





High heat and chemical resistance and low cost dictate choice of cold molded plastics for air contactor arc chutes (above) and control housing (below). (Photos, Rostone)

Bituminous binder: This binder is composed of asphalt, gilsonite, stearine pitch, or vegetable pitch blended with oils, such as linseed, castor, and tung, to form a varnish-like resin. This resin is reduced to proper viscosity with solvents, mixed with asbestos fiber, seasoned, ground, and finally screened.

Phenolic binder: Phenolic resin is treated with a solvent to produce a solution of the proper viscosity; then it is mixed with asbestos fiber, seasoned, ground, and screened to proper size.

Since the cold molded plastics can be squeezed into shape by pressure alone, production is rapid—as high as 3500 to 4000 pieces/hour with certain types of equipment. Baking, required to set the piece after shaping, can be accomplished for a large number of pieces simultaneously, and usually consumes one to several days depending upon the size and cross-section of the piece. On small thin pieces the baking cycle may be considerably under 24 hr.; heavier cross-sections may require up to 72 hours. When organic binders are used, the temperature starts at approximately 175° F. and is raised in hourly increments of 10 to 20 degrees to approximately 450° F.

Ease of fabrication varies according to the type and percentage of abrasive components. Mold wear is also affected by abrasive content. In general, cold molded articles tolerate metal inserts.

General characteristics: Cold molded articles usually lack the surface smoothness, gloss, and appearance that characterize hot molded items. Dimensional differences are relatively large. Through modification of compounds and advances in processing, strides have been successfully made in stabilizing and improving these characteristics.

With some of the newer types of compounds, dimensional variation and design limitations are not so critical. Tensile strength has been improved. Baking is not necessary unless increased tensile strength is essential, or accelerated setting is desired. Color range has been greatly broadened. Mold wear has been reduced. New free-flowing powders are adaptable to rotary presses, and small pieces can be pressed up to 300/minute.

Phenolic compositions surpass bituminous types in both mechanical and electrical properties, and can be made with a finish that is at least comparable to that obtained in hot molding. Both types exhibit resistance to high heat and most alkalies and solvents, and are nontoxic and relatively low in cost. Most of these compositions are molded on hydraulic presses supplied with oil pressure ranging from 2000 to 4000 p.s.i. The somewhat soft pieces are seasoned on perforated trays at room temperature before baking.

Applications: Cold molded organic plastics find applications in many electrical products, such as connector plugs, switch bases, attachment plugs and caps, sockets, outlet covers, and others.

References

Consult the Subject Index for additional information concerning cold molded organic plastics. See also the Plastics Properties Chart for information on properties and trade designations. For sources of cold molded plastics, see Directory Index, p. 1018.

"Influence of exposure conditions on the accelerated durability testing of asphalt," by L. R. Kleinschmidt and S. H. Greenfeld, ASTM Bulletin No. 213, 69 (Apr. 1956).

"Time and temperature effects on the deformation of asphaltic bitumens and bitumen-mineral mixtures," by C. Van der Poel, SPE J. *11*, 47 (Sept. 1955).

"Bituminous plastics," by D. A. Turner, Brit. Plastics *22*, 32 (Jan. 1950).

Coumarone-Indene, Petroleum, and Polyterpene Resins

BY P. O. POWERS*

RECENT DEVELOPMENTS

A new series of styrene copolymers have been introduced (*Piccoflex 100, 105,* and *115,* Pennsylvania Industrial Chemical Corp.). The 115 variety is available in flaked form; the other two are available in solid form. These resins have been used in coatings, particularly where excellent water and solvent resistance is required. They are especially adaptable to use in floor coverings, particularly asphalt-filled tile formulations. When properly compounded they can be used for making tile possessing excellent color and color stability, resistance to kerosene and vegetable oils, and good flexibility.

Several new hydrocarbon resin emulsions of petroleum resin have been recently offered (*Piccopale Emulsion A-22, XA-43, N-3,* and *XC-1,* Pennsylvania Industrial Chemical Corp.). A-22 is especially recommended for use with polyvinyl acetate emulsions where it improves adhesion and scrubbability. The XA-43 is particularly recommended for use in paper sizing. The N-3 is a new nonionic emulsion, with excellent stability and unusual resistance to shear. The XC-1 is a new cationic emulsion and on drying exhibits extremely good water resistance characteristics.

An improved terpene polymer (*Piccolyte S115-L,* Pennsylvania Industrial Chemical Corp.) has notably improved color over the usual varieties of terpene polymers; the color is Gardner 2 or better.

Coumarone-indene resins are derived principally from indene; other resins usually classed with coumarone-indene are derived from styrene, cyclopentadiene and their homologs, and other unsaturates.

These resins are being offered in a wide variety of forms from soft resins to hard brittle resins of 140° C. softening point as determined by the A.S.T.M. E-28, ball-and-ring softening point method. The color of the resins also varies widely—from pale resins of less than Coal Tar Color 1, to resins that are dark brown in color. Heavy aromatic oils that find application as plasticizers and as plasticizer extenders are also produced.

The iodine value of the resins may range from practically 0 to over 200, depending upon the starting materials and methods of manufacture. The iodine value does not measure unsaturation quantitatively but indicates reactivity with oxygen.

Finally, the coumarone-indene resins vary considerably in solubility; most of them, however, are soluble in aliphatic solvents, such as mineral spirits. Some of the higher melting varieties require 10 to 30% of aromatic hydrocarbons in the solvent. Certain polymers are soluble in acetone.

The polystyrene resins are rather lower in molecular weight than the polystyrene materials used in the molding field. They are thermoplastic and offer a variety of melting points ranging from 25 to 150° C. These resins are available in flaked, bead, or solid forms. They are soluble in aromatic hydrocarbons as well as in the aromatic petroleum naphthas.

The resins are produced by treating the unsaturated streams with an acid catalyst. The type of catalyst, the temperature of reaction, and the concentration of the reactants determine the type of resin produced. Often the different streams are blended together to reproduce resins of the desired characteristic. After the catalyst has been removed, the solution of resin is dried by evaporation, either with steam or in vacuum or by a combination of both.

Coumarone-indene resins are widely used in coatings, particularly in aluminum vehicles, a field in which their nonpolar character is essential. Coumarone-indene resins are also widely used with drying oils in preparing varnishes of many types. They are occassionally used in conjunction with other resins in preparing varnishes. The resins, in general, have little reactivity with the drying oils, although some types are more soluble after heating with the oil. Part of this effect, however, may be due to depolymerization of the resin. The coumarone-indene type resins do add considerable water resistance and alkali resistance to vehicles in which they have been incorporated.

Concrete sealers, flat wall paints, and wall primers are typical uses, as is membrane curing of concrete.

Asphalt tile continues to be one

* Pennsylvania Industrial Chemical Corp., 120 State St., Clairton, Pa.

Recent Developments and References were prepared by the editors.

of the large outlets for the coal tar hydrocarbon resins. A decade ago these resins were the principal resins used, but the large increase in volume in this field has necessitated the use of other types of resins, particularly petroleum resins. Unlike coumarone-indene resins, however, which can be used as the single resin constituent in tile manufacture, petroleum resins require reinforcement with polystyrene or other more reactive materials. In recent years, polystyrene scrap has been widely used with the petroleum resins for this purpose; coal tar hydrocarbon resins also may be used.

Coumarone-indene resins find a major outlet as aids for softening and processing, and also as reinforcing resins with natural and synthetic rubber. The softer grades are used with the oil-resistant synthetic rubbers as softeners and tackifiers. The harder grades have been found to produce a resin-reinforcing effect, particularly with the butadiene-styrene synthetic rubber.

Petroleum resins

The production of petroleum resins has increased rapidly in the last decade as the supply of coal tar crudes remained relatively stationary, and new types have been added periodically.

The first petroleum hydrocarbon resins offered were rather dark in color and highly unsaturated. However, with improvements in manufacturing methods, a wide range of petroleum resins have now been made available with good color and good stability to aging. The differences between petroleum and coal tar hydrocarbon resins are also tending to disappear and the aromatic content of some petroleum resins is already quite high. Light-colored petroleum resins are soluble in mineral spirits in all proportions. Resins are available in solid and flaked form at melting points of 100° C. and higher. Petroleum resin emulsions of good color are available in all types of emulsion form, both of the anionic and nonionic types, adapted for use in coatings and paper size, and for other industrial applications. Petroleum resins vary somewhat in iodine value and some possess quite high iodine values. Some unsaturated resins absorb oxygen readily, but where this property is undesirable, antioxidants will prevent this change occurring.

In the mastic tile field, petroleum resins are largely used but usually require some higher-molecular-weight material such as polystyrene to reinforce them. Plasticizers from the petroleum field are also used with the resins. Coal tar resins are sometimes used with the petroleum resins in mastic tile manufacture.

Petroleum resins are widely used in rubber compounding. The softer resins are used as plasticizers, while the harder resins are used to impart stiffness to synthetic rubbers. A notable improvement in tensile strength and cut growth is accomplished by the incorporation of such resins in the formulation.

Pale petroleum resins can be used with the drying oils to produce water-resistant varnishes. Gloss and adhesion are also improved by their use. Color stability of petroleum resins is considerably better than that of the coal tar resins. Petroleum resins find extensive applications in adhesives and saturates. They are also widely used to modify other resins. Petroleum resins are readily soluble in paraffinic and chlorinated hydrocarbons but are generally insoluble in the lower alcohols or ketones.

The use of petroleum resins as a saturant for corrugated boxes and as a paper size is being extended, as is the use of these resins in fiberboards.

Terpene resins

Polyterpene resins are firmly established in the adhesives and coatings fields, and wherever a readily soluble hard resin of good color is required. In the last year the polyterpene resins have been in rather short supply due to the greatly increased demand.

Commercial polyterpene resins are lower in density than the coal tar or most petroleum resins. Recent improvements in manufacturing methods have resulted in better and lighter-colored resins. Grades melting from 10 to 135° C. ball-and-ring are produced. The harder varieties are available in flake form. They are composed in their entirety of hydrocarbon.

The terpene resins are used with drying oils in varnishes. Such varnishes made with tung oil have exceptional heat resistance. The vehicles containing terpene resins are characterized by their generally good color retention properties.

Polyterpene resins are compatible with many waxes and may be used in emulsion waxes. They are compatible with polybutenes, chlorinated and cyclized rubbers, and long-oil alkyds. They are used in concrete curing compounds where a pale solution is required. Since polyterpenes blend readily with natural and synthetic rubbers, they are used in rubber compounding and are widely employed in adhesives. Since these resins are nontoxic, they can be employed in food packaging. They are popular in pressure-sensitive adhesives where the properties of tack, light color, and stability are of decided advantage.

References

Consult the Subject Index for additional information concerning coumarone-indene, polyterpene, and petroleum resins. See also the Adhesives and Coatings Charts for information on properties and trade designations. For sources of these resins, see Directory Index, p. 1018.

"Terpene polymers," by P. O. Powers, preprint booklet, Paint, Varnish & Printing Inks Div., American Chemical Society, 1957 Spring Meeting.

"Compatibility of coumarone-indene resin/solvent systems," A. C. Zettlemoyer and Jack Vanderryn, Ind. Eng. Chem. *49*, 220 (Feb. 1957).

"Coumarone-indene resins," by A. C. Zettlemoyer and E. T. Pieski, Ind. Eng. Chem. *45*, 165 (Jan. 1953).

"Terpene resins," by W. J. Roberts and A. L. Ward, chapter in Encyclopedia of Chemical Technology, vol. 12.

"Coumarone-indene resins," by Carl E. Snyder, SPE News *4*, 1 (Apr. 1948).

Epoxy Resins

BY GEORGE EPSTEIN*

Epoxy resins represent a relatively new and intriguing class of synthetic resins which have found wide application in reinforced plastics, adhesives, coatings, castings, etc.

The epoxy resins are known under a wide variety of designations. The terms epoxy, epoxide, ethoxy, ethoxyline, and oxirane are derived from the fact that these resins are characterized by the  functional group, which may be so termed. The designation "epichlor(o)hydrin resins" results from the fact that epichlorohydrin, a liquid chemical, is generally employed as one of the starting materials in the manufacture of the resins.

Historical development

In 1863 the German chemist A. Wurtz prepared ethylene oxide, and then studied some of its reactions. During the next 80 years various chemists, notably Lindeman, Staudinger, and Schlack, learned how to prepare polymeric resinous materials based on Wurtz's earlier studies. The development of manufacturing and processing techniques was undertaken during World War II and in subsequent years by a number of leading materials suppliers and other interested companies.

From practically zero output prior to 1950, the manufacture and consumption of epoxy resins was reported to have reached almost 30 million lb. in 1954, and was estimated at about 90 million lb. in 1956.

Resin synthesis

The commercial synthesis or manufacture of epoxy resins largely depends upon the reactivity of the oxirane ring  with compounds containing hydroxyl groups (—OH). Epichlorohydrin, in particular, is used in conjunction with various bi- or polyhydroxyl compounds. This chemical is a colorless liquid, boiling at 116°C., and has the chemical structure shown in Fig. 1, below.

Reactions can occur through both the oxirane ring (epoxy group) and the chlorine atom. Use is made of this extensive reactivity both in the preparation of the epoxy resins and in the subsequent curing or hardening of the resins. Reactions can occur with sources of active hydrogen (—H), such as amines, acids, and acid anhydrides, and with compounds containing the hydroxyl (—OH) functional group, such as alcohols and phenols.

The reaction of epichlorohydrin with bi-functional hydroxyl-containing compounds (i.e., with two —OH groups per molecule) is the basis for the manufacture of the commercial epoxy resins. Bisphenol-A (see Fig. 2, right, for chemical structure) is of particular interest because of its symmetrical structure and because it is the most economical dihydric phenol produced in large volume and in relatively pure form. It is a solid with a melting point of 153° C. Glycerol, resorcinol, cresol, various glycols, catechol, hydroquinone, polyhydroxy naphthalenes, novolak-type phenolic resins, and other phenol derivatives are among the many other hydroxyl compounds which may be employed. Some commercial resins are prepared with glycerol and resorcinol, but at present the most important types of commercial resins are based on bisphenol-A.

Chlorohydrins other than epichlorohydrin, such as glycerol dichlorohydrin

($ClCH_2CHOHCH_2Cl$),

can be employed.

Novolak resins (prepared by reacting excess phenol with formaldehyde), treated with epoxylating agents such as epichlorohydrin, can result in resins containing appreciably more reactive epoxy groups per molecule than the standard commercial products. (Diepoxides have a theoretical maximum of two epoxy groups per molecule.) Such resinous products have a greater degree of reactivity, and hence are capable of producing higher heat-distortion temperatures.

Epoxidation of unsaturated (C=C) organic materials offers an attractive means for manufacture of a variety of epoxy resins. Hydrogen peroxide and organic peracids, e.g., peracetic, perbenzoic, and perphthalic acids, are capable of converting unsaturated groups to epoxy (see Fig. 3, below). A diepoxide synthesized by this process was recently announced. Heat-distortion temperatures greater than 450° F. were reported when this resin was cured at 320°F for 6 hr. with HET anhydride and a small quantity of base catalyst.

General properties

The viscous liquid epoxy resins are employed most commonly in casting, potting, laminating, and adhesive-bonding applications. The solid grades are used generally for coatings, and in some cases for laminating and adhesive-bonding applications.

The resins described above are thermoplastic long-chain (essentially linear) pre-polymers (see

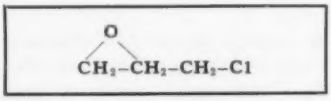


Fig. 1

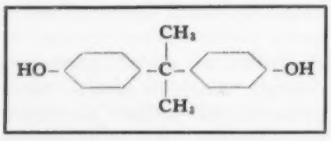


Fig. 2

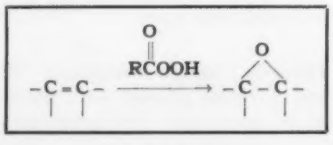


Fig. 3

A self-hardening plastic-metal compound (*Formex No. 77*, Travaco Laboratories) has half the density of equivalent compounds and a controlled pot life of from 3 to 90 minutes. When mixed with the catalyst supplied, it hardens like granite in minutes, forming a permanent bond with plastics, metals, wood, ceramics, and concrete.

Epoxy resins for primary electrical insulation are now available in tape form (Minnesota Mining & Mfg. Co.). The tapes, in fibrous glass cloth form (*X-1035*) and in a nonwoven fibrous polyester mat form (*X-1045*), are impregnated with uncured epoxy resin. After oven cure, the resin sets into a hard, homogeneous mass around the protected unit providing mechanical support and a moisture barrier. The tapes are designed to meet Class B electrical insulation performance requirements.

A clear, pale, low-viscosity epoxy resin (*Epi-Rez 507*, Jones-Dabney Co.) has been developed to fill the growing need for flexible epoxy compositions. Cured resins range from tough, flexible products to hard, high-impact resistant materials. The mixture has a long pot life and cures with a very low exotherm. By the use of an accelerator, it is possible to obtain a wide range of stability and speed of cure.

A curing agent (4,4′-diaminodiphenylsulfone, Merck & Co., Inc.) for epoxy resins is said to improve the high-temperature performance and electrical characteristics of the cured resins.

A protective cream (*Kerodex*, Ayerst Labs.) is useful as a deterrent of contact dermatitis among workers who handle epoxy resins, glass fibers, etc. It is available in both water-repellent and water-soluble types.

Bonding agents consisting of epoxy resins alloyed with metal and nonmetal reinforcements (*Resiweld Plastic Alloys*, H. B. Fuller Co.) are said to give permanent and impact-resistant bonding to practically all plastics, metals, wood, glass, concrete, and other surfaces.

An epoxy resin wrinkleproofs white cottons, gives them a "wash-and-wear" finish, and prevents discoloration (*Eponite*, Shell Chemical Corp.). The resin permits washing, bleaching, and ironing of white goods without yellowing or loss of strength.

An epoxy compound (*Flawmaster*, Carl H. Biggs Co., Inc.) is described as a metal putty useful for filling blowholes of various sizes in both machined and raw castings. It is supplied in a kit, as a three-component compound consisting of resin, hardener, and a supply of very finely pulverized blended powder. It can be cured at room temperature.

A high heat-resistant epoxy resin formulation, with a heat distortion temperature of 600° F., can be mixed at room temperature and has a cure cycle of 6 to 8 hr. at 300° F. One version of this material (*Epoxylite No. 811-9*, Epoxylite Corp.) can be used to prepare molded coil insulation for large electric motors. A second version (*Epoxylite No. 813-9*) is suitable for potting all varieties of electrical apparatus. A third version (*Epoxylite No. 812-9*) is recommended as an extremely versatile heat-curing adhesive.

An epoxy hardener (*No. 888*, Marblette Corp.) makes possible epoxy castings and laminates with a heat resistance between 600 and 700° F., according to the manufacturer.

New transparent, flexible, and foam encapsulating compounds (Telectro Industries Corp.) are available for industrial and commercial applications. The transparent compound sets in 15 min., is inexpensive, consists of only two components, and is easily released from the molds. The flexible compound is an epoxy formulation featuring variable flexibility and is less expensive than other epoxy formulations. The foam compounds are available in various densities and require low temperatures to 150° F. for curing.

An inexpensive room temperature-curing epoxy resin (*Maraset No. 616*, Marblette Corp.) has been used to make bulk-mass application castings to 300 pounds.

A low-viscosity hardener (*Sonite No. 23*, Smooth-On Mfg. Co.), for use with an epoxy resin casting compound (*Sonite XI*) used in potting and encapsulation, imparts flame, mechanical, and thermal shock resistance.

The hardness of a new lead-epoxy compound (*Leadcast*, Telectro Industries Corp.) can be controlled from that of a rubberlike material to that of cast aluminum. Applications are primarily in the field of radiation shielding in source containers, instrument housings, interlocking bricks for temporary or removable shielding, and the like.

A two-component epoxide casting resin (*Stycast 2741*, Emerson & Cuming, Inc.) imparts controlled flexibility to the finished product. It retains flexibility at −70° F. and is recommended for encapsulating, potting, and sealing applications requiring low-temperature use. It can also be used at 300° F. without harmful effects.

For patching and protecting eroded concrete, epoxy resins (*Epocast* resins, Furane Plastics, Inc.) are available. Various formulations are required to fill the cracks, apply fillets to corners, and coat the entire area for protection.

Epoxy-tar protective coatings (*Carbomastic*, Carboline Co.), for use in general maintenance, equipment exteriors, tank linings, and floors, have a solids content ranging from 85 to 90 percent.

Fig. 4, below). As such, they are soluble in a wide variety of solvents. Ketones, esters, alcohol-ethers, and chlorinated hydrocarbons are particularly effective, the solubility of the resins decreasing as molecular weight and softening point increase. Alcohols and aromatic hydrocarbons are not active solvents for the solid grades. The liquid resins are quite soluble in aromatics, e.g., benzene, toluene, and xylene, but not in alcohols. Alcohol-aromatic hydrocarbon solvent combinations may be employed in conjunction with solid resins for coatings.

The end groups of these resins are extremely reactive epoxy groups and, for n = 1 or greater, the chain contains secondary alcohol (—OH) groups which are also reactive under certain conditions. The molecular chain consists only of C—C and ether linkages, which account largely for the excellent chemical resistance and stability of the resin when fully cured, as compared with the polyesters. The wide spacing between the functional epoxy and hydroxyl groups assists in providing inherent flexibility. The highly polar groupings contained by the molecule provide the excellent adhesion to metals and to a wide variety of other surfaces which are polar and/or polarizable in nature. The etherification of the phenolic OH group accounts for the good color retention and alkali resistance of the epoxies. Due to the large variety of chemical groupings included within the molecular chain structure (alkyl, aryl, etc.) the epoxy resin tends to be compatible with a variety of other resins and elastomers, e.g., phenol-formaldehydes, urea-formaldehydes, polyvinyls, and polysulfide and nitrile rubbers.

The presence of epoxy and hydroxyl groups in the uncured resin results in high intermolecular association. Hence, during cure, changes in volume are quite small (i.e., there is very little shrinkage) and associated strains are minimized. The fact that no volatiles are given off during cure is, of course, another significant factor in minimizing shrinkage.

Impurities not removed from the resinous product (e.g., uncombined reactants, phenol, caustic, salt) will impair the physical and mechanical properties of the final material. There is also a tendency toward inhibition of cure when amine curatives are involved. It is for these reasons that thorough washing is the practice in the manufacture of epoxy resins.

Curing

The cross-linking and coupling processes involved in transforming the thermoplastic epoxy resins into hard, rigid, thermoset solids are designated as curing. "Hardening," "converting," and "setting" are alternative designations describing this chemical transformation, whereby physical and chemical properties are altered in the direction of increased strength, hardness, rigidity, etc.

The mechanisms by which epoxy resins are cured are dependent upon the nature of the curatives employed. Two types of materials generally are used: 1) amines and 2) acids (anhydrides).

In general, epoxy resins cured with amines have shorter pot lives or working times, shorter curing cycles, and higher exotherms, i.e., considerable heat may be evolved during the curing reaction. Curing at room temperature or only moderately elevated temperatures (e.g., 200°F.) is frequently possible. Anhydride-cured resins, on the other hand, usually have longer pot lives, longer curing cycles, and appreciably lower exotherms. Moderate to high temperatures (300 to 500°F.) usually are required for curing. Higher concentrations of anhydride curatives are necessary for effective curing. This is usually an advantage for handling purposes. Representative commercial curing agents are listed in Table I, p. 108.

Surface coatings

Epoxy resins have found widespread use in surface coatings due to their excellent adhesion, durability, and chemical resistance. There are three major families of epoxy-base surface coatings: 1) epoxy-phenolic and epoxy-urea; 2) epoxy-esters; and 3) epoxy-polyamines.

Epoxy-phenolic and epoxy-urea: High-molecular-weight epoxy resins are heat-cured with urea, melamine, or phenolic resins to form coatings with maximum hardness and chemical resistance to acids, alkalies, and solvents. Reaction of the epoxy occurs through the methylol groups ($-CH_2OH$). Phenolic modifications have poorer color and require higher baking temperatures (350°F.) than urea-formaldehyde resins; however, they have greater chemical resistance. Aromatic or ketone solvents usually are used for thinning these blends, with a solids content of 35 to 40% for spraying.

Epoxy - phenol - formaldehyde coatings are outstanding in applications requiring maximum chemical resistance and toughness, such as drum linings, wire enamels, coatings for food containers and collapsible tubes, and protective coatings for metal furniture, pipes, tanks, tank cars, ducts, etc. Epoxy-urea-formaldehyde coatings tend to be somewhat more flexible and are used in similar applications. They have excellent color retention and produce superior white baking finishes.

Epoxy-esters: Fatty acids may be incorporated with epoxy resins by esterification to low acid values, under inert gas at temperatures of about 500° F. Drying-oil fatty acids generally are

Fig. 4

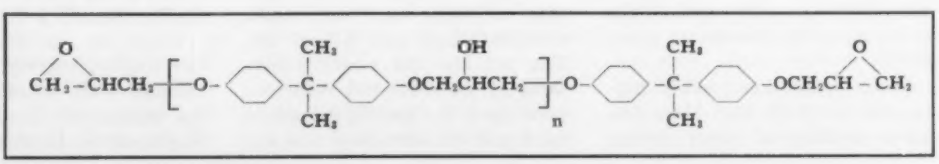


TABLE I: Representative commercial curatives for epoxy resins

Source	*Chemical type*	*Characteristics and usage*[1]
Applied Plastics Co.		
No. 150	Aliphatic amine	For large castings; LTS
No. 170	Aliphatic polyamide	Rapid curing; for laminating; LTS
No. 180	Polyamine	Non-toxic[2]; short pot life; for laminating; LTS
No. 186	Alicyclic amine	Non-toxic; for potting and casting; LTS
No. 210	Aromatic amine with side-chain substitution	
No. 320	Aromatic amine	Non-toxic; for casting and laminating; HTS
No. 322	Aromatic polyamine	Non-toxic; excellent toughness and solvent resistance; HTS
Armour and Co., Armour Chemical Div.		
"Duomeen" S	N-soya propylene diamine	Moderate pot life; requires careful mixing; flexibilizing agent, increasing resilience and impact resistance; LTS
Bakelite Co.		
ERL-2793	Aliphatic amine adduct	Hygroscopic; viscous liquid; short pot life; LTS
ERL-2807	Aliphatic amine adduct	Hygroscopic; low-viscosity liquid; short pot life; LTS
ZZL-0803	Modified aliphatic polyamine	Hygroscopic; low-viscosity liquid; slow curing; LTS
ZZL-0812	Modified aliphatic polyamine	Hygroscopic; low-viscosity liquid; slow curing; LTS
Ciba Co., Inc.		
HN-901	Acid anhydride (solid)	Long pot life; requires careful mixing; long curing cycles at elevated temperatures; especially for electrical applications; HTS
HN-906	Acid anhydride (Methyl Nadic[3] Anhydride)	Long pot life; low-viscosity liquid; high-temperature curing; HTS
HN-951	Aliphatic amine	Short pot life; room-temperature curing possible; LTS
HN-956	Modified amine	Non-toxic; short pot life; low-viscosity liquid; room-temperature curing; LTS
Epoxylite Corp.		
Catalyst No. 1	Aliphatic amine	Short pot life; room-temperature curing; LTS
Catalyst No. 7B	Aromatic amine blend	Moderate pot life; high-temperature curing; HTS
Catalysts No. 6, No. 8, and No. 9	Acid anhydrides (modified)	Long pot life; high-temperature curing; HTS
Furane Plastics, Inc.		
Hardener 909	Acid anhydride	HTS
Hardener 927	Aromatic amine	Long pot life; low-viscosity liquid; high-temperature curing; HTS
Hardener 931	Aliphatic amine	Long pot life; LTS
Hardener 985	Modified amide	Long pot life; LTS
Hardener 989	Modified amine	Non-toxic; room-temperature curing; LTS
Hardener 9810	Modified amine	Non-toxic; available in colors; room-temperature curing; LTS
(Note: Furane also carries curatives of Ciba Co.)		
General Mills Inc., Chemical Div.		
Versamid 100 and 115	Polyamides	Non-toxic; extremely viscous liquid; low-exotherm; improved flexibility and impact resistance; room-temperature curing possible; LTS
Versamid 125	Polyamide	Non-toxic; viscous liquid, more fluid than Versamid 115; low exotherms; improved impact resistance; room-temperature curing possible; LTS
Hastings Plastics, Inc.		
Hapex 1201	Aliphatic amine	Short pot life; room-temperature curing; LTS
Hapex 1221	Aliphatic amine	Moderate pot life; room-temperature curing possible; LTS
Hapex 1210	Modified aromatic amine	Long pot life; low-viscosity liquid; high-temperature curing (to 300° F.); HTS

See Footnotes on opposite page.

used. Film properties are not equal to those of epoxy-phenolic resins, but have better performance qualities than standard alkyd baking enamels. Epoxy-esters may be baked or air-dried through the addition of driers, especially cobalt naphthenate.

Styrenated esters (containing styrene in addition to the epoxy-fatty acid ester) are faster-drying, and have good weathering and alkali resistance. Rosin esters are prepared by esterifying the epoxy resin with rosin, and then dispersing the resulting product in a drying oil by heating at about 550°F.

Epoxy-esters are readily pigmented to yield high-gloss finishes, capable of rapid drying, high abrasion, and mar resistance, as well as excellent adhesion, durability, and chemical resistance. Applications include spar varnishes, printing inks, cement paints, metal primers, coatings for food containers, tools, and various items of hardware, and protective coatings for use in chemical plants.

Epoxy-polyamines: A third family of coatings results when epoxy resins are cross-linked with polyamines. For surface coatings, the epoxy resin is put into solution, and the amine catalyst added just before use. The pot life and curing conditions of the catalyzed resin depend upon the specific polyamine used, and the solvent system and amount thereof. A few percent of urea-formaldehyde resin frequently is included in order to improve the surface leveling characteristics.

Polyamides give greater flexibility, but less chemical resistance than polyamines. They have been used as coatings for paper and cardboard.

Epoxy-Thiokol polysulfide mixtures, cured with amines, provide a range of flexibility. Such systems are used for protection of strain gages and for low-permeability liners in pressure vessels.

Clear or pigmented amine-cured epoxy coatings are also obtainable with outstanding chemical resistance. They are being employed in chemical plants and

TABLE I: Representative commercial curatives for epoxy resins (Continued from opp. page)

Source	Chemical type	Characteristics and usage[1]
Jones-Dabney Co.		
Epi-Cure 82	Aliphatic amine adduct	Short pot life; rapid curing at room temperature possible; high exotherms; LTS
Epi-Cure 83	Modified aliphatic amine	Long pot life; moderate-temperature curing (to 200°F); low exotherms; LTS
(Note: Mixtures of Epi-Cure 82 and 83 are recommended for controlled reactivity.)		
Epi-Cure 84	Aromatic amine mixture	Long pot life; low-viscosity liquid; high-temperature curing (to 300°F); postcure (400°F) for optimum properties; HTS
Epi-Cure 85	Aliphatic amine adduct	Short pot life; room-temperature curing; used with Epi-Cure 82 to adjust flexibility; LTS
Marblette Corp.		
No. 661, No. 665, and No. 680	Aliphatic amines	LTS
No. 900 and No. 903	Aromatic amines	HTS
No. 888	Acid anhydride	HTS
Naugatuck Chemical Div., U.S. Rubber Co.		
TONOX-PL	Modified aromatic amine (methylene dianiline)	Long pot life; solid, generally melted for ease of mixing; HTS
Rohm and Haas Co.		
DMP-10	Dimethylaminomethylphenol	Low-temperature curing; LTS
DMP-30	Tri(dimethylaminomethyl)phenol	Low-temperature curing; LTS
Shell Chemical Corp.		
Curing Agent A	Diethylaminopropylamine	Short pot life; liquids, somewhat volatile; room-temperature curing possible; LTS
Curing Agent CL	Metaphenylenediamine	Long pot life; solid, requires melting for use; high-temperature curing (to 300°F); postcure (400°F) for optimum properties; HTS
Epon Curing Agent Z	Aromatic amine mixture	Long pot life; low-viscosity liquid; high-temperature curing (300°F); HTS
Epon Curing Agent D	2-Ethyl hexoic acid salt of DMP-30	Moderate pot life; moderate-temperature curing (to 250°F); excellent for castings; LTS
Curing Agent DDS	Diaminodiphenylsulfone (DDS)	Long pot life; solid powder, requires heating or dissolving for mixing; requires high-temperature curing and postcures (to 400°F); HTS
Epon Curing Agent BF_3-400	Boron trifluoride-monoethylamine complex	Very long pot life; high-temperature curing (200-450°F); LTS; recommended with DDS to accelerate cure.
Epon Curing Agent T	Aliphatic polyamine	Non-toxic; short pot life; room-temperature curing possible; recommended for automobile body patching and tooling; LTS
Epon Curing Agent U	Modified polyamine adduct	Short pot life; easily handled; moderate-temperature curing (to 200°F); LTS
Smooth-On Mfg. Co.		
"Sonite" No. 01	Aliphatic amine	Short pot life; room-temperature curing possible; LTS
"Sonite" No. 41	Aromatic amine	Long pot life; low-viscosity liquid; cures at 212°F; postcure at 300°F for optimum properties; HTS
Wyandotte Chemicals Corp.		
Monolene	Monopropylene oxide adduct of ethylenediamine	Short pot life; low-viscosity liquid; room-temperature curing; lighter colored products; LTS
(Note: Addition of Quadrol, the tetrapropylene oxide adduct of ethylenediamine, increases pot life and reduces exotherm when used in conjunction with Monolene.)		

[1] LTS = low-temperature service (up to 200°F.); HTS = high-temperature service (above 200°F.).
[2] "Non-toxic" materials actually may be "practically non-toxic" or "slightly toxic."
[3] Trademark, National Aniline Div., Allied Chemical & Dye Corp.

other industrial applications where damaging corrosive atmospheres may exist.

Adhesives

Epoxy-base adhesives have found extensive usage in joining a wide variety of materials to one another, particularly where high strength and ease of application are desired. Curing can be effected with the application of just sufficient pressure to insure positioning of the adherend faying surfaces. Excellent gap-filling characteristics often are an attractive feature.

A large number of commercial products are available for low-temperature service (up to 200°F.). Some of these can be cured at room temperature, though for maximum strength a heat cure generally is desirable. Two-part systems require mixing just prior to use and have a limited working life. Several one-part systems now are available which require no mixing, have an extended storage life, but require curing at elevated temperatures.

Formulations are available suitable for structural service at temperatures up to 500-600°F. (e.g., epoxy-phenolic adhesive tapes). Adhesives for service at elevated temperatures (above 200°F.) require curing at temperatures above 300°F.

Major applications of epoxy-base adhesives are in the bonding of metals and reinforced plastics; wood, most rubbers, ceramics, and many thermoplastics also are bonded. Notable exceptions are silicone rubber, fluorinated polymers (e.g., Teflon and Kel-F), polyethylene, and some vinyls. Chemical treatment of Teflon can result in fair bonds.

Because volatile by-products are not given off during cure, large areas can be joined with minimum precautions. Sandwich constructions, made by joining honeycomb and other core materials to various types of facings (or skins), such as metals, plastics, and glass plate, are finding increased usage in load-carrying structures (especially aircraft and missiles), thermal insulation (especially for refrigeration), and

decorative applications (e.g., office partitions, table tops, and skylights).

Resistance to various chemicals and weathering permits the use of epoxy-base adhesives wherever corrosion-resistant joints are necessary.

The inherent brittleness and the concomitant poor peel resistance of epoxy-base adhesives frequently are minimized by employing adhesive primers with excellent "peel strength." More flexible adhesive formulations are available (containing suitable flexibilizers), but at a sacrifice in strength at elevated temperatures and in resistance to creep.

Laminates

Reinforced plastic laminates are fabricated using epoxy resins with various types of reinforcements, e.g., glass fabrics, mats, and rovings, asbestos felts, paper, cotton, nylon, Dacron, and other fabrics, and metal foils. Compared with other resins, laminates from epoxy resins provide the optimum mechanical-strength properties, including wet strength retention, as well as excellent electrical properties for service at temperatures up to about 300°F.

Vacuum-bag molding, contact molding (especially with tacky, liquid resins i.e., by wet lay-up), and matched-die molding are the most common fabrication techniques. Pressure-bag molding is employed less frequently.

Curing agents used with liquid epoxy laminating resins include diethylenetriamine (for rapid cures at room temperature, by wet lay-up); diethylaminopropylamine (for curing at moderate temperatures, by wet lay-up); and aromatic amines, especially meta-phenylenediamine and mixtures (these require curing at elevated temperatures and then postcuring for optimum properties, by wet or dry lay-up).

Dicyaniamide is frequently used as a curing agent with the solid resins. Reinforcements are impregnated with solutions prepared by dissolving the ground resin-curative mixture in volatile solvents (e.g., ketones and water), and then drying. Such systems are nontacky and have a long storage life; however, they require dry lay-up techniques and curing at elevated temperatures (above 300°F.) under moderate pressures (25 to 200 p.s.i.).

Epoxy-phenolic blends provide improved heat resistance. Blends with furan resins result in reduced material costs and possible improvements in mechanical properties. Epoxy-Thiokol polysulfide blends and epoxy-polyamide copolymers provide greater toughness and impact resistance.

Epoxy laminates are ideal for structural and electrical applications. Radomes, electrical terminal boards, printed electronic circuits, aircraft skins, facings for honeycomb sandwich structures, ducting, pipes, tanks, and pressure vessels are typical. Patching of automobile fenders represents a potential market.

The filament-winding process, employing continuous glass roving and epoxy resin, provides an ideal means for fabricating spherical and other intricate shapes. When suitable liner materials are included, such structures are suitable for containing gases and liquids at pressures of several thousand pounds per square inch.

Excellent thermal insulating characteristics have resulted in numerous rocket and missile applications.

Shatter-resistant characteristics, coupled with high strength-to-weight ratios, have led to their use in many pressure vessels, primarily for military applications.

Castings

A wide selection of modifiers and curing agents can be employed with liquid epoxy resins to produce castings for numerous applications. In addition to the tooling field, epoxy casting resins are widely used in the electrical and electronics industries. Delicate electronic components, such as miniaturized tubes, capacitors and resistors, connectors, rectifiers, transformers, and motor stators, frequently must be protected against humidity, heat, weathering, chemicals, vibration, and other adverse service conditions. The low shrinkage (less than 2%) of epoxy casting resins, in addition to excellent electrical, chemical, and mechanical properties, has resulted in their widespread use for these purposes. Formulations generally are required to be fluid and to cure at low to moderate temperatures with a low exothermic heat rise. Fillers, which increase viscosity, help to minimize exotherms by dissipating the heat developed during cure; also, they reduce shrinkage.

The excellent wetting characteristics of epoxy resins can provide excellent impregnation not only of electrical components but also of structures such as porous castings (for sealing purposes).

In order to reduce viscosity, diluents (e.g., allyl glycidyl ether and phenyl glycidyl ether) frequently are added. Ten parts of diluent added to 100 parts by weight of resin will reduce the resin viscosity to a considerable degree without seriously impairing strength properties.

Tooling

Plastic tools and dies are being fabricated from epoxy resins for use in the automotive, aircraft, and other industries. Applications include metal-forming tools for stretching, drawing, etc., assembly and machining fixtures, locating fixtures, foundry patterns, vacuum forming dies, and numerous others. Even precision tools such as Keller models, checking fixtures, drilling fixtures, and matched dies can be made, taking advantage of the low shrinkage of epoxy resins especially when filled with inert materials, to obtain dimensional reproducibility.

Fabrication techniques consist primarily of laminating and casting. Laminates are used for thin tools and when maximum mechanical strength is required. For tools over 1 in. in thickness, casting is more suitable and considerably cheaper.

Foams

Epoxy resins can be converted into foamed or expanded plastics which are suitable for many applications, e.g., encapsulation of electronic components, thermal insulation, and as core materials in sandwich-type structures.

Two-component liquid systems are available which have relatively short working lives. Heat is essential to induce foaming, and

may be supplied externally or result from the exothermic heat of the curing reaction. When potting delicate components, or if a very uniform cell structure is desired, high exotherms must be avoided. Additional heat curing generally is recommended after the foaming operation. An excellent foamed cell structure has been reported for an epoxy-polyamide system, which can be prepared with external heating, using dimethyldinitrosoterephthalamide as the blowing agent.

Single-component epoxy foaming resins, in powder form, have extended storage lives.

In both types, a chemical blowing agent must be included in the formulation, as well as the curative. The blowing agent is responsible for liberation of the gas which produces the expansion of the epoxy resin. Wetting agents also are frequently included. When necessary, a volatile liquid may be added in order to absorb some of the exothermic heat.

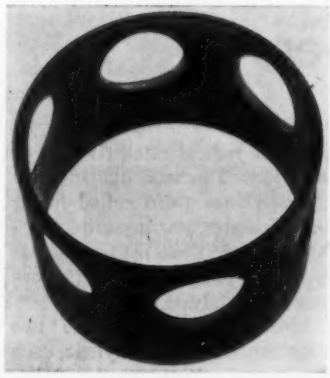
Molding compounds

Materials are being developed, based on epoxy resins, which are expected to provide dimensionally reproducible parts fabricated by compression and transfer as well as plunger molding. Several molding materials now are commercially available. Powders or viscous pastes (premixes) may be employed. Inert filler materials are essential components. Molding materials require molding cycles of only 1 to 10 min. at temperatures of 250 to 350° F. and pressures of a few up to several thousand pounds per square inch.

Excellent adhesion (to inserts), chemical resistance, and mechanical strength, versatility in formulating, and low mold shrinkage are desirable attributes. Release from mold or cavity surfaces can be troublesome, and requires precautions with respect to mold design and the use of release agents. Fire- and heat-resistant characteristics can be introduced by proper selection of curatives.

Miscellaneous uses

Low-molecular-weight epoxy resins are used as *stabilizers* for chlorinated vinyl polymers, notably polyvinyl chloride, polyvinylidine chloride, and copolymers, due to their ability to act as acid (HCl) acceptors.



Modified epoxy resin formulation used for glass-reinforced nozzle adapter for rocket motor withstands high temperatures

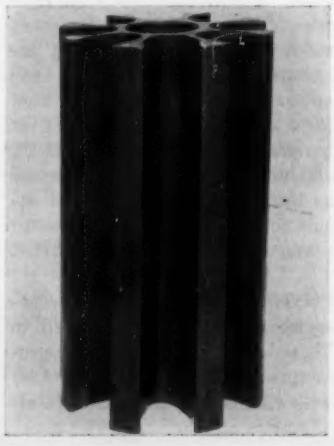
Polymeric-type epoxy *plasticizers* for vinyls are available, some of which also serve as heat and light stabilizers. For low-temperature flexibility, a monomeric epoxidized ester is available; it shows promise in plastisol formulations. Such materials permit the processing of vinyls at higher temperatures.

Epoxy-base *putty* and *solder* compounds (in paste or stick form) are finding many industrial uses. These are highly filled (e.g., with aluminum dust or iron powder) epoxy resins, which are spread over the area to be covered, and cured in place. Finishing operations such as drilling, filing, and sanding are readily performed. Typical applications include the repairing of metal and plastic tooling and dies, and automobile body and fender repairs.

Investigations are being conducted on the possible uses of epoxy resins in combatting *dental* problems, especially tooth repairs. Good adhesion to enamel and dentin are attractive advantages.

Cements and *mortars* based on epoxy resins are used in joining brick or tile in floors and tanks, where their chemical resistance offsets high material costs.

Low shrinkage of epoxy resin permits close dimensional reproducibility in precision casting of tool



References

Consult the Subject Index for additional information concerning epoxy resins. See also the Adhesives, Coatings, and Plastics Properties Charts for information on properties and trade designations. For sources of epoxies, see Directory Index, p. 1018.

"Thin-wall epoxy-glass tubing," by W. E. Ponemon, MODERN PLASTICS *34*, 139 (Nov. 1956).

"Polysulfide-epoxy compositions," by E. H. Sorg and C. A. McBurney, MODERN PLASTICS *34*, 187 (Oct. 1956).

"Polyamide-epoxy resins," by D. E. Floyd, W. J. Ward, and W. L. Minarik, MODERN PLASTICS *33*, 238 (June 1956).

"Epoxy-ether resins: a new technology," by E. G. Shur, MODERN PLASTICS *33*, 174 (Apr. 1956).

"Room-temperature bonding," by J. L. Been, MODERN PLASTICS *33*, 126 (Mar. 1956).

"A potting compound and mold for precision pottings," by W. H. Crandall, SPE J. *12*, 20 (July 1956).

"Long-term strengths of reinforced epoxy pipe," by H. D. Boggs, Plastics Tech. *2*, 459 (July 1956).

"Epoxy resins for electrical applications," by H. Rudoff and A. J. Rzeszotarski, SPE J. *12*, 31 (Feb. 1956).

"How to make and repair epoxy dies," by N. E. Talbert, Modern Machine Shop *28*, 128 (Jan. 1956).

"Epoxy casting resins modified with polysulfide liquid polymer," by K. R. Cranker and A. J. Breslau, Ind. Eng. Chem. *48*, 98 (Jan. 1956).

Ethylene Polymers

Polyethylene is the second largest and the fastest growing of all plastics materials. By the end of 1955, the rate of consumption of conventional polyethylene approached 400 million lb. and in 1957 it is nearing 700 million lb. If the newer high-density polyethylenes reach expected production, total polyethylene consumption in the United States may reach 1 billion lb. by 1960.

Basically, polyethylene is synthesized by the polymerization of ethylene at elevated temperatures and pressures in the presence of suitable catalysts. Conventional low-density polyethylene (also known as branched polyethylene, high-pressure polyethylene, etc.) requires very high synthesis pressures (15,000 to 30,000 p.s.i.) and uses free radical catalysts such as peroxides. The stiff high-density polyethylenes (also called linear polyethylenes, low-pressure polyethylene, etc.) are made at lower synthesis pressures, using coordination catalysts.

Although these are the two main classes of polyethylene, each constitutes a large family of different resins.

Fundamentally, a polyethylene molecule is made up of a long chain of carbon atoms, each with two hydrogen atoms attached. The molecule usually contains between 800 and 100,000 carbon atoms.

During the synthesis process, the active end of a growing molecule sometimes dislodges a hydrogen atom from the middle of another molecule, producing an active site which results in the growth of a long-chain branch at that point. As might be expected, a polyethylene containing a sizable proportion of such branched molecules exhibits different flow properties in the molten state than one without long-chain branching.

A second type of reaction which may occur during the synthesis process results in the formation of many short branches (2 to 4 carbon atoms in length) at irregular intervals along the main chain and the longer branches. These short branches are responsible for the great differences in solid state properties which exist between the branched and linear types of polyethylene.

Crystallization

One of the properties of the type of hydrocarbon chain found in polyethylene is a tendency to crystallize. Crystallization is said to have occurred when a number of chains, lying in approximately parallel alignment, assume a more compact configuration, producing a small crystal or "crystallite." A single hydrocarbon chain or long branch may pass through

This article is based on information supplied by the following companies: E. I. du Pont de Nemours & Co., Inc.; Bakelite Co.; Spencer Chemical Co.; Hercules Powder Co.; Phillips Chemical Co.; and Eastman Chemical Products. Recent Developments and References were prepared by the editors.

RECENT DEVELOPMENTS

Lead-filled polyethylene (*Leadolene,* Telectro Industries Corp.), for use in radioactive shielding applications, produces a homogeneous casting that is smooth-surfaced, resistant to oxidation, and recastable without loss of material. The composition is 95% lead and 5% polyethylene, but this can be varied to meet specific requirements. The lead content shields against beta and gamma rays, the hydrogen (supplied by the polyethylene) against neutrons.

A fungicide-treated industrial paper material (*X-Crepe N,* Cincinnati Industries, Inc.) uses polyethylene as a moisture-vapor barrier. The material is a cross-creped heavy-duty paper with all-directional stretch. Polyethylene is laminated between two plies of the paper which is then coated on one side with polyethylene. Fungicide is applied to the paper side or exterior of the case liner. It is recommended for case liners and other industrial uses wherever a strong, clothlike, stretchable, baceteriostatic, polyethylene-coated material is required.

An irradiated extrusion grade polyethylene compound (*E-234,* General Electric Co.) is being evaluated for use in wire coating and insulating. The compound can be extruded directly onto wire as easily as conventional polyethylene. Also in the development stage are a semiconducting irradiated polyethylene tape for power cables, a new grade of tape to withstand physical stress at temperatures higher than 350° C., and heat-shrinkable tubing for use as lead insulation, as ground insulation on small component parts, and as a corrosion barrier.

Polyethylene plumbing accessories are now being offered in high-density material by a manufacturer (American Vulcathene) who claims that his series (*Universal*) of wastes and traps made of this material have high chemical resistance and are capable of handling boiling water continuously.

A synthetic mineral wax (*FT-300,* Dura Commodities Corp.), produced by the synthesis of carbon monoxide and hydrogen, can be blended with high-pressure polyethylene to increase its rigidity. These mineral waxes have approximately the same melting point as high-pressure polyethylene and have a high softening point. They are said to be superior to paraffin wax, petroleum wax, or other mineral waxes for maintaining heat resistance of the polyethylene.

Addition of a hard hydrocarbon wax (*Paraflint,* distributed by Moore & Munger) to polyethylene is said to result in a molding compound with a higher melt index than the polyethylene alone and also to improve the feel, gloss,

several crystallites, with disordered or "amorphous" portions between. The presence of short chains, however, restricts the formation of crystallites.

The amorphous and crystalline forms differ in several properties, of which two may be cited by way of illustration. Compared with the amorphous material, the crystalline material is harder and stiffer (because the closely parallel chains are bound together) and it is denser. The higher density in the crystallites is due to the "close-packing" of the resin chains in the crystalline lattice. X-ray measurements indicate a density of 1.00 for the crystallites. The density of the amorphous regions are not known with certainty since various types of measurements lead to figures ranging from 0.76 to 0.85.

In any resin, therefore, the relative percentages of crystalline and amorphous materials will determine the density of the whole resin. A completely (100%) crystalline resin would have a density of 1.00 and a wholly amorphous resin would have a density in the vicinity of 0.80. Between these extremes, density and percent crystallinity vary.

Since many of the properties of polyethylene, therefore, depend on the density or crystalline content of the resin, nomenclature used in this article will be based on *density*—low-density for the conventional polyethylenes and high-density for the newer polyethylenes. The intermediate-density materials will also be discussed.

Melt index

The amount and types of branching, as well as the average molecular size, affect the flow properties of the molten polyethylene in a complicated manner. To simplify this complex problem, it is convenient to determine the fluidity of the melt under a set of rigidly specified conditions. The number of grams of molten polymer which will flow through a standard orifice at a standard temperature and pressure in a given time is called the *melt index* of the polymer. Thus, the higher the melt index, the more fluid is the melt. This test provides a rough measure of the behavior to be expected from the resin under actual fabrication conditions, as well as its performance in certain use-tests which depend on molecular weight.

Molecular weight

Unfortunately, it is sometimes observed that melt index is not a true indication of the ease of flow during processing. This fact stems from the non-Newtonian nature of molten polyethylene. In a Newtonian fluid, the amount of flow is always directly proportional to the stress applied. In other words, the viscosity is the same whether the stress is little or great. In the case of polyethylene, on the other hand, the greater the applied stress, the lower the viscosity becomes. The amount of departure from Newtonian behavior is greatly affected, in polyethylene, by the breadth of the *molecular weight distribution*. If two polyethylenes of the same melt index

---

and stiffness of the finished product. This wax, which has a low viscosity and crystalline structure, melts at 215°F. It can be blended with both the high- and low-pressure-processed polyethylenes and is said not to impair impact and tensile qualities.

Low-pressure polyethylene extruded sheet (Campco Div., Chicago Molded Products) can be readily vacuum formed. It is available in both Ziegler and Phillips types. Specific gravity is 0.945 for Ziegler and 0.96 for Phillips, and heat distortion points at 66 p.s.i are, respectively, 140 and 168° F.

Polyethylene film (*Visqueen*, Visking Corp.) has been found by a Philadelphia construction firm (Robert E. Lamb & Sons) to be useful in separating freshly-poured concrete panels used for walls in tilt-up slab construction methods. The film may be used more than once and may later be used over again for various other types of applications at the construction site.

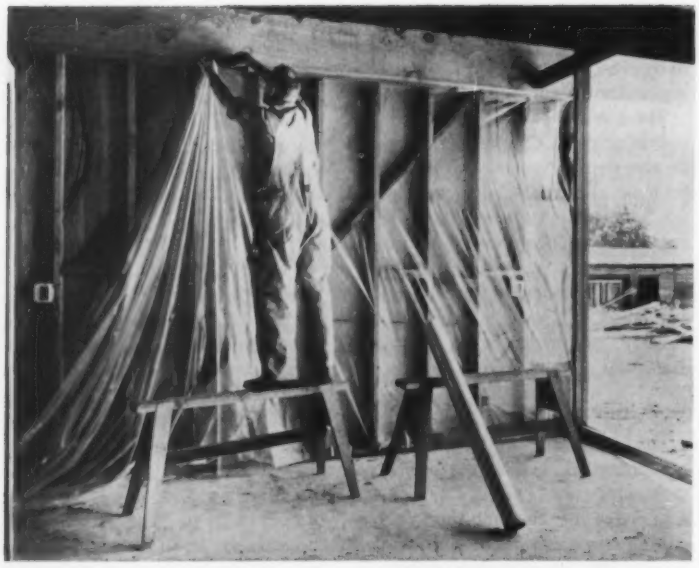
Vacuum pouches made from a specially-treated polyethylene film (Cryovac Co., Div. of W. R. Grace & Co.) have extremely high resistance to the transfer of gas, air, and moisture. The bags are intended for packaging sliced food products sold in consumer-sized units.

A new ink system (*RP series*, Claremont Pigment Dispersion Corp.) for gravure printing on treated polyethylene offers all the performance properties of conventional gravure inks. Available in a full color range, including metallics, these storage stable, concentrated inks provide the printer with the flexibility necessary to adjust inks for printing with engravings of any depth and pattern.

A line of polyethylene toys (Payton Products, Inc.) is treated with a bacteriostatic compound (*Corobex*, Bex Industries, Inc.) used to make molded plastics, textiles, and other products germproof, self-deodorizing, mold-static, and fungus-static.

Color dispersions for injection molding (*Formacolor LP*, Westchester Plastics, Inc.) and extrusion (*Unicolor LP*) of linear polyethylene are mixed in a linear polyethylene base to form masterbatches which can then be extended by the molder or by the extruder.

A new type of plastic pipe (*Klearcor*, Western Plastics Corp.) is composed of a core of unpigmented polyethylene covered by an outer sheath with high carbon-black pigment concentration. The outer sheath which serves as an added safety factor and as an ultra-violet shield is guaranteed by the manufacturer not to separate from the clear core.



Promising market for polyethylene film is as an easily-installed moisture vapor barrier material in side walls of homes and buildings. (Photo, Visking)

have different molecular weight distributions, the resin of narrower distribution will have the greater apparent viscosity at stresses above that applied in the melt index test. Conversely, the resin of broader distribution of molecular weights will have the higher apparent viscosity at very low shear stresses.

Selecting the polyethylene

Barring additives or contamination, any polyethylene can be defined by the values of these three parameters: density, melt index, or molecular weight. The effects of the three parameters, taken separately, are as follows:

1) *Density:* As the density increases: a) stiffness increases; b) yield strength increases; c) Graves tear strength increases; d) Elmendorf tear strength decreases; e) resistance to creep increases; f) Vicat softening temperature increases; g) impermeability to liquids and gases increases; h) brittleness temperature decreases; i) film brittleness increases; and j) flex life decreases.

Density has no effect on the properties of the molten polymer, since crystallites do not exist in the melt.

2) *Melt index:* As the melt index is increased: a) melt fluidity increases (viscosity decreases); b) melt "drawability" increases; c) film coefficient of friction increases; d) tensile strength decreases; e) Elmendorf tear strength decreases; f) resistance to environmental stress cracking decreases; g) low-temperature toughness decreases; and h) Vicat softening temperature decreases.

3) *Molecular weight distribution:* A decrease in the breadth of the molecular weight distribution has these effects: a) tensile strength increases; b) film brittleness decreases; c) low-temperature toughness increases; d) Vicat softening temperature increases; e) resistance to environmental stress cracking increases; and f) ease of processing at high shear stresses decreases.

It is evident from the foregoing that once a prospective fabricator or user of polyethylene decides on the properties which are most important to him, he can select the best resin for his purpose by the proper choice of density, melt index, and molecular weight distribution.

LOW-DENSITY POLYETHYLENE

Ethylene was first polymerized by Fawcett and Gilson in the late 1930's. They discovered that, when ethylene was subjected to pressures of the order of 1000 to 2000 atmospheres and temperatures in excess of 100° C., in the presence of oxygen or peroxide catalysts, a solid polymer was formed. Most of the low-density polyethylene manufactured today is made by this basic process.

Chemical structure

The properties of polyethylene resin depend on the chemical structure of the polymer molecules. The simplest structure which can be drawn for the polyethylene molecule is:

$CH_3- - -CH_2CH_2CH_2CH_2- - -CH_3$

Evidence from infra-red spectra and other sources indicates that the chain is not linear and regular as shown but is interrupted by various irregularities. Small amounts of unsaturation are present, but the main type of irregularity is branching. According to recent evidence, these branches are probably four carbons long in resins made by the high-pressure process.

To appreciate the effect of branching, first consider straight chains without branching. Without branches to protrude and interfere, the chains have a good chance of lining up parallel with other chains. The result of the tendency to parallelization is a structure in which any one chain is somewhat curled, but all along the length it is parallel with other chains and close to them. When the possibility of parallel alignment of simple molecules of the polyethylene type exists, it is usually found that crystallization or freezing take place. In the crystal, the spatial arrangement of the molecules is in a definite geometric configuration.

INTERMEDIATE-DENSITY POLYETHYLENE

In the past year, commercial quantities of a new type of intermediate-density polyethylene have become available. These intermediate-density resins have properties that fall in-between the high-density and low-density types, although they are made by a modification of the high-pressure process used for making the low-density polyethylene.

The unique performance of this

intermediate range stems from the fact that, while the physical properties of polyethylene vary with the density, the relationship is not a straight-line function in most cases. It just happens that the density property lines fall in such a way that in many important properties the greater part of the improvement possible by increasing density, has already been obtained in this range. One of the limitations to the use of the low-density polyethylene, for example, is its permeability to many liquids and gases. This permeability is greatly decreased by an increase of density, and about 80% of the improvement possible has already been obtained in the intermediate range. Heat resistance is in the same category. The largest and most significant increase in heat resistance has already been achieved in the intermediate-density range. In addition, some of the properties which are sacrificed because of higher density, e.g., impact strength, fold endurance, etc., reportedly will show less of a loss in the intermediate-density range.

The range on the melt index scale where the transition between waxy and plastic polyethylene appears is strongly influenced by density. In low-density polyethylene a melt index of 50 is still safely on the plastic side, in high-density polyethylene a melt index of 1 is already near the transition range to wax. In the intermediate-density range, the edge of the transition to the waxy state is in the vicinity of melt index 8 or 10 so that materials of good properties can be made up to a melt index of 2 or 3. This will generally permit normal processing.

TABLE I: Comparison of properties of polyethylene in the three density classes.

Property	*Low-density*	*Intermediate-density*	*High-density*
Density	0.91-0.93	0.93-0.94	0.94-0.96
Hardness (Shore D)	40-50	50-63	63-70
Stiffness modulus, p.s.i.	10,000-25,000	25,000-50,000	50,000-140,000
Tensile strength	1500-2000	2000-2800	2800-6400
Elongation, %	200-550	200-500	25-500
Heat resistance, °F.	212	240	250

HIGH-DENSITY POLYETHYLENE

Polyethylene having a higher density, and significantly different properties from the familiar material, is produced by a much different process than the previously-discussed types. In this process ethylene is dissolved in a solvent at moderate pressures, usually 500 to 1000 p.s.i., and the solution is placed in contact with one of a number of widely differing catalysts which are insoluble in the solvent. Active centers on the surface of the catalyst polymerize the ethylene by means of a co-ordinating or directing mechanism which, in most cases, results in a "straight chain," or substantially unbranched polyethylene molecule.

The absence of branches permits the molecules to pack together more closely and results in a denser material.

In all polyethylenes there is some tendency for the molecules to conform to each other to form crystallites. The unbranched material is able to do this more completely. The term "straight chain" is often misleading since the configuration of the molecule is actually coiled. When these coils crystallize they form an interlocked spiral crystallite. A number of these crystallites grow out from a center into a structure called a spherulite. The general picture is not unlike a mass of well-entangled fine springs.

In the low-density polyethylene, crystallite and spherulite are embedded in a considerable amount of amorphous material which is responsible for the flexibility, and also for the permeability. This amorphous material also adds to shock resistance by distributing stresses. In the high-density material little of such yielding material remains. This makes the size of the spherulites extremely critical. Slow cooling of the melt, or any considerable length of service at elevated temperature results in growth of the spherulite to a size at which stress concentrations appear. When this happens the material becomes extremely brittle.

The high-density materials are therefore stronger, stiffer, less ductile, more heat resistant, and less permeable. See Table I, above, for comparison of properties.

The main difference between these and the intermediate-density resins is that the density change has gone so far that the material is hardly recognizable as polyethylene and should not be considered merely as another or an improved polyethylene. It is in many ways an entirely new type of material.

APPLICATIONS

All the polyethylenes—low-density, intermediate-density, and high-density—can be molded or extruded into a wide variety of useful products. Some of the more outstanding market areas for the various polyethylenes are discussed below.

Injection molding

Polyethylene has grown rapidly in the molding field because of its "nonbreakability," flexibility, ease of processing and col-

Typical of the king-size pieces being molded of polyethylene is a 10-gal. colorful garbage can. (Photo, Eastman Chemical)



oring, chemical resistance, and low cost. The molding industries account for about 17% of the polyethylene produced.

For injection molding, polyethylene in pellet form is available with melt indices ranging from 1.5 to 20. Molders may choose a type that best suits their requirements for molding performance and physical properties. The high melt index types permit molding of large objects such as wastebaskets and garbage cans and also offer the additional advantages of superior gloss. Lower melt index types find use in applications requiring greater rigidity, strength, and resistance to environmental cracking.

About half of the low-density material goes into such housewares as bowls, buckets, wastebaskets, garbage cans, containers, etc. Other large outlets for molded low-density polyethylene are closures for squeeze tubes, spouts for detergent cans, and shoe parts.

A large proportion of high-density polyethylene will undoubtedly also find a place in the field of molded objects. Because equal stiffness can be obtained with thinner cross-sections, it will be more economical in many molded items than low-density material. Its high heat resistance will also open up large fields now denied to the lower-softening-point materials.

Intermediate-density materials which fall in the range between these two should also find new uses. They have improved stiffness and gloss, without much sacrifice of flow properties, coupled with improved heat resistance.

Film and sheeting

To date, film has consumed more polyethylene than any other fabricated form. Since 1953, more than a third of all polyethylene used in the U. S. has been converted to film. Over 80% of the film produced now goes into the packaging of foods, textiles, toys, hardware, machinery, and chemicals. Although the importance of polyethylene film in the packaging industry will undoubtedly continue to increase, some non-packaging applications are expected to grow even more rapidly in the near future. Agricultural and construction uses, in particular, are just gaining momentum and can be expected to expand tremendously. Polyethylene film provides the means for revolutionary new techniques of agriculture, leading to increased yields with reduced labor. In the construction industries, it is finding ready acceptance as a water-vapor barrier, and as a means of temporary protection of materials from the weather.

Polyethylene film is produced mainly by extrusion, either from a flat die with water quenching or by the blown-tubing method. Some film is produced by calendering but the difficulties of this process have greatly limited its commercial development. Some of the new films provide exceptional clarity combined with improved slipping and blocking characteristics. When special properties are required, the user may select one of the blends of polyethylene with rubber or other materials. Film made from high-density polyethylene displays excellent slip properties, and is completely nonblocking. The flat die and water tank process produces high-density film having excellent transparency and surface quality. "Blown" film may be somewhat less transparent than low-density film. In both cases, the higher stiffness modulus is quite apparent, and this may be desirable for pushing film through automatic packaging machinery.

The technique for sheet extrusion is almost identical to that used for impact-type styrene sheet. Outstanding surface quality can be achieved with a flat die and a three-high roll stack take-off. For example, a combination of 390° F. stock and 220° F. roll temperatures has produced a high-gloss surface which was not lost during subsequent forming operations. Furthermore, sheeting that will not deform when reheated can be produced by avoiding "draw-down," i.e., sheet thickness is as great as, or greater than, the die opening.

The large-scale use of heavy sheeting, however, has been retarded by the lack of well-developed fabrication techniques. As the necessary techniques are worked out, and sheeting with the required properties becomes available, a great increase in the production of polyethylene objects by the thermoforming of heavy sheet will occur. At least initially, the bulk of this effort will probably be in the packaging field. Later, many items now produced by the more expensive injection molding process will undoubtedly be thermoformed. High-density polyethylene is a particularly attractive material for this process because of its greater stiffness, and techniques are already being developed for forming it.

Barrel-like 13-gal. polyethylene drum is light in weight, unbreakable, and corrosion-resistant. (Photo, Plax Corp.)



Electrical insulation

High electrical resistivity and good dielectric characteristics, particularly at high frequencies, have made polyethylene an important material in electrical insulation. About 15% of the polyethylene now produced is used for electrical insulation or jacketing. During World War II, nearly all the available polyethylene was used for insulation in communication service, particularly high-frequency applications. Polyethylene is used as an outer jacket on power cables, telephone lines, television lead-in wire, and appliance wire where it serves as both insulation and as a protective barrier against moisture, weathering, and abrasion. Some

of the higher melt index types are also used, usually compounded with polyisobutylene or synthetic rubber to improve their environmental crack resistance. However, improved crack resistance is usually obtained by the use of low melt index grades of resin. High-density polyethylenes are run in the cross-head extruders normally used for wire coating, and make possible the production of wire having greatly increased resistance to heat and abrasion. Its greater strength and resistance to damage during manufacturing operations will permit the use of thinner insulations. Low-density polyethylene may be largely replaced in this field.



Irradiated polyethylene tape is wrapped around cable containing telephone wires. The tape is made highly resistant to heat and environmental stress-cracking by bombarding conventional polyethylene film tape with high-velocity electrons. (Photo, General Electric Co.)

Pipe

Polyethylene pipe is finding steadily increasing acceptance for farm, mine, and home uses, primarily in the transportation of cold water. It is available in sizes ranging from ½ to 6 in. in diameter. Its principal advantage over other plastic and metal pipes is its flexibility, which allows lengths up to 1500 ft. to be coiled for shipment. This results in great ease of installation. Other advantages are its immunity to rupture through freezing, and complete resistance to corrosion. Polyethylene pipe is colored black (with 2 to 3% of finely divided carbon black) for protection against ultra-violet light. At present, pipe accounts for about 13% of the polyethylene produced in the U. S., and this proportion will probably not change greatly in the next few years.

The position of high-density polyethylene in the pipe field has not yet been established, but it is not expected to compete seriously with the more flexible materials in their present uses. One of the desirable features of low-density polyethylene pipe is its flexibility, which permits marketing in easily-handled coils, whereas the higher stiffness modulus of the high-density type will necessitate shipment in straight lengths, with the accompanying need for joints. In many installations, however, the increased heat resistance of the high-density pipe will be of greater importance than the reduced flexibility. Long-time burst strength of high-density pipe is only marginally better than low-density pipe. Joining the semi-rigid, high-density pipe with standard threaded joints has been found to be fully practicable, and short-term bursting tests have shown that properly assembled threaded joints are not points of weakness. For the production of pipe, the extended mandrel technique has been found to be the most dependable and trouble-free.

Coatings

Of the various methods of coating other materials with polyethylene, only extrusion-coating is of commercial importance at present. In this process, a very thin film of polyethylene is extruded directly onto a moving web of paper, aluminum foil, or other sheet material. About 7% of the polyethylene consumed in the U. S. goes into extrusion-coating applications. The great bulk of this is extruded onto paper for multiwall bags, wrapping and lining papers, and pouch bags. Coated aluminum foil is heat-sealable, and provides a package which is absolutely waterproof. Cellophane and polyester film coated with polyethylene are finding increasing acceptance for packaging applications requiring greater strength, impermeability, or heat resistance than would be provided by polyethylene alone. Fabrics have been extrusion-coated with polyethylene to render them waterproof, or better able to retain finely powdered materials. Nonwoven mats of cellulose fibers are coated to produce disposable baby diapers and hospital sheets. A probable large future application is the coating of board stock for milk cartons and other liquid containers.

To all these combinations, low-density polyethylene contributes wear resistance, heat-sealability, form retention, and moisture resistance. The lower permeability of high-density polyethylene may lead to its use in extrusion-coating, although modified coating methods will be required.

Metal surfaces can be coated with a heavy layer of polyethylene by flame spraying. In this process, a stream of finely powdered polyethylene suspended in an inert gas is introduced through the nozzle of a torch resembling a gas welding torch. The metal surface is first preheated by the

flame, and the molten particles stick to it and fuse together to form a continuous coating. A fluidized-bed technique is used to coat small irregularly-shaped metal objects. The object to be coated is first heated, and then suspended in a "boiling" bed of finely divided polyethylene. The heat of the object melts the particles on contact, resulting in a uniform coating of controllable thickness.

Bottles and tubes

Polyethylene can be blow molded into bottles and collapsible tubes for cosmetics, drugs, foodstuffs, and chemicals, and has had particular success in baby bottles. In this field, polyethylene has gained great popularity because of low cost, resistance to breakage and corrosion, "squeeze" flexibility, and sales appeal. In the blow molding process, an extruded tube is formed to shape in a mold by air pressure. Large carboys and drums can be made by welding or blow molding.

Special polyethylenes have been developed to meet the particular flow requirements of various custom processes. In some packaging applications, the use of polyethylene alone has been restricted by the diffusion of essential oils and other volatile substances through the wall of the container. However, this limitation has been reduced by the use of lining compounds.

High-density polyethylene can be processed in conventional equipment in accordance with the usual procedures for making bottles of low-density polyethylene. For many applications, the increased rigidity and heat resistance will outweigh the reduced flexibility. "Squeeze bottles" can be made by designing plane or slightly curved faces which will display a diaphragm or "oil-can" action. Extruded polyethylene tubing fitted with two metal ends also shows possibilities. The lower permeability of the high-density bottles should permit a greatly broadened use of plastic bottles and containers in the packaging of cosmetics, pharmaceuticals, and miscellaneous chemicals.

Work is also being done with linings for polyethylene bottles that will decrease permeability.

Clothes sprinkler is molded of polyethylene to take advantage of the material's resiliency and eye appeal. (Photo, Bakelite)



Filaments

This market is relatively small in low-density polyethylene, and complete displacement can be expected, together with rapid growth in total input. Filaments produced from high-density polymers can be oriented by stretching 800 to 1000% and have shown tensile strengths comparable to the best synthetic fibers, with excellent abrasion resistance. The combination of low cost, high-tensile, good chemical inertness, and good heat resistance should be of real value in cordage, fish nets, filter cloths, upholstery, and the like.

Since the high-density polymers are still simply polyethylenes, they require the usual protection from the degrading effects of oxidation and sunlight. Commercial anti-oxidants have proved effective. Carbon black is still the best light absorber for wire, pipe, and other items that will be subjected for any length of time to outdoor exposure.

Miscellaneous uses

There are a number of minor applications for polyethylene which, in total, account for an impressive quantity of material. Thick compression molded slabs are used in the shielding of nuclear reactors. Thinner sheets are used in the construction of tanks, tank linings, and many types of chemical process equipment. Small-diameter tubing is used in aerosol dispenser cans, automobile battery separators, industrial instrumentation, and medical applications.

Other uses for polyethylene are potting delicate electrical mechanisms by injection molding and centrifugal casting of large tubes or pipe. Low-molecular-weight polyethylenes are used in emulsions, wax blends, and in rubber processing.

References

Consult the Subject Index for additional information concerning polyethylene. For information on injection molding, see p. 650; on compression molding, see p. 680; on extrusion, see p. 702. See also the Adhesives, Coatings, Films, Laminates, and Plastics Properties Charts for information on properties and trade designations. For sources of polyethylene, see Directory Index, p. 1018.

"Stereospecific catalysis and isotactic polymers," by G. Natta, Angewandte Chemie *68*, 393 (June 21, 1956); MODERN PLASTICS *34*, 169 (Dec. 1956).

"Polyethylene fibers face brighter future," MODERN PLASTICS *34*, 132 (Dec. 1956).

"Mold temperature effects in polyethylene molding," by C. S. Imig, MODERN PLASTICS *34*, 149 (Dec. 1956).

"King-size moldings," MODERN PLASTICS *34*, 123 (Oct. 1956).

"Film on the farm," MODERN PLASTICS *34*, 112 (Sept. 1956).

"Grading of polyethylene by ZST test," by H. S. Kaufman and C. O. Kroncke, MODERN PLASTICS *33*, 167 (Mar. 1956).

"Hard-wearing monofilaments replace traditional materials," Brit. Plastics *29*, 316 (Sept. 1956).

"Properties of Marlex 50 ethylene polymer," by R. V. Jones and P. J. Boeke, Ind. Eng. Chem. *48*, 1155 (July 1956).

"Polyethylene—past and future," by G. W. Jargstoff and G. F. Kirkpatrick, SPE J. *12*, 25 (June 1956).

"Polyolefins: will three be a crowd?" Chem. Week *78*, 79 (June 16, 1956).

"The first boilable film bag," Modern Packaging *29*, 174 (Mar. 1956).

Fluoroethylene Polymers

Polytetrafluoroethylene

BY E. D. CHAMPNEY, JR.*

Polytetrafluoroethylene resins are high polymers of tetrafluoroethylene created by polymerization under carefully controlled conditions. As a consequence of having a molecular structure consisting of carbon and fluorine atoms, they possess a unique combination of outstanding chemical and physical properties. This is a result of the true fluorocarbon system where the primary bonds in the polymer chain are very strong, the secondary valence forces between adjacent chains are weak, and the symmetrical arrangement of fluorine atoms forms an impenetrable sheath protecting the carbon chain.

Tetrafluoroethylene resins are produced as granular powders for compression molding, as special powders normally used with an extrusion aid to produce extruded articles such as insulated wire, and as aqueous dispersions for coating metals and fabrics.

Properties

In addition to their exceptional heat and chemical resistance, polytetrafluoroethylene articles have many other useful properties. Their low dissipation factor and low dielectric constant make them useful in the electrical industry. These properties are only slightly altered at elevated temperatures.

Another unusual property of polytetrafluoroethylene is the material's exceedingly low coefficient of friction—lower than that for any other solid—which makes it useful as a bearing material. The static coefficient is equal to the dynamic value; thus, polytetrafluoroethylene resin does exhibit a slip-stick type of motion.

The impact strength of the material is extremely high but many of the other mechanical strength properties, while adequate for many uses, are not exceptional. Even though many plastics exhibit better properties at room temperature, there are no organic plastics that retain useful mechanical properties over as wide a temperature range. For example, after 1 mo. at 480° F., bars molded of polytetrafluoroethylene showed only a 1% loss in tensile strength.

The value of polytetrafluoroethylene for certain applications can be considerably enhanced by the use of additives. This improves certain mechanical properties and also permits various types of compositions to be tailored to a wide variety of chemical, mechanical, and electrical applications. As an example, resistance to wear by rotating shafts can be increased as much as 500 times through the use of additives. The modified compositions retain most of the outstanding properties of uncompounded polytetrafluoroethylene. Also, elongation and impact strength are lowered, but in most instances these changes do not impair the usefulness of the articles.

Some of the properties of polytetrafluoroethylene, e.g., good thermal and chemical resistance, nonadhesiveness, low dissipation factor, and low dielectric constant

*Product Specialist, E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington 98, Del.

Recent Developments and References were prepared by the editors.

RECENT DEVELOPMENTS

A perfluorocarbon resin (*100-X*, Du Pont) approaches the unique heat and chemical resistance of conventional polytetrafluoroethylene (*Teflon*) but can be extruded in conventional equipment because of its low melt viscosity. The resin has been extruded into film on conventional equipment. It may even be injection molded.

Cementable Teflon tapes, in fibrous glass cloth-reinforced form as well as unsupported, are available (Continental-Diamond Fibre Corp.) in widths from ¼ to 12 in. and in thicknesses from 0.002 to 0.060 inch. Either one or both surfaces is made cementable by treatment with a sodium-ammonia mixture. The material is suggested for use in low-friction and nonsticking chute and hopper linings, electronic components insulation, etc.

Woven glass fabric (Shamban Engineering Co.) coated with polytetrafluoroethylene (*Teflon*) has very low flow under combined heat and pressure. It remains pliable at temperatures below −100° F. and inert up to 390° F. The material does not crack when creased under moderate pressure. Among its applications are conveyor belts for use in food, candy, and other industries in which sanitation and ease of release are important.

Fluorocarbon plastic can be copper-clad without using a resin adhesive thanks to the development of a special bonding technique (International Resistance Co.). The resulting laminate exhibits very low cold flow, zero water absorption, good machinability, and water-repellency.

Fibrous glass cloth impregnated with polychlorotrifluoroethylene (United States Gasket Co., Div. of The Garlock Packing Co.), for linings and surfaces exposed to extreme corrosive conditions, has high chemical resistance to acids (including nitric and hydrofluoric), alkalies, oxidants, and most solvents. The glass cloth is impregnated through half its thickness, and the glass backing furnishes the bonding surface.

High - density polytetrafluoroethylene extruded shapes can be made faster and in a wider range of dimensions on a newly designed extruder (Tri-Point Mfg. & Developing Co.). The equipment produces extrusions with a minimum of orientation and weak spots.

are relatively insensitive to fabrication techniques, while others such as stiffness, flex life, permeability, and tensile strength, are to a large extent under the control of the fabricator.

Processing methods

Tetrafluoroethylene resins are fabricated by a number of techniques including screw extrusion, ram extrusion, preforming followed by pressure or free sintering, extrusion with an extrusion aid (naphtha), calendering, coating and dip-coating, and impregnation. These techniques, while different, have three basic steps in common; 1) cold-forming; 2) sintering; and 3) cooling.

In spite of the outstanding chemical resistance of polytetrafluoroethylene, it is possible sufficiently to disturb the surfaces by special treatment so that they can be adhered to various substrates using a variety of conventional adhesives.

For applications where continuous resin-to-resin joints are required, as in tank linings for chemical process equipment, sheet stock may be heat-bonded. This technique employs a simple contact heater at a temperature of about 710° F. with the aid of a flux and a contact pressure of about 35 p.s.i.

Polytetrafluoroethylene is extremely stable at high temperatures.

Polychlorotrifluoroethylene

BY J. A. JUPA*

The polymer molecule of trifluorochlorethylene consists of a carbon skeleton and two halogens —fluorine and chlorine—present in a mole ratio of 3:1. The chlorine atom contributes to the transparency, moldability, and rigidity characteristics of the plastic, while the fluorine atoms are responsible for its chemical inertness, thermal stability, and zero moisture absorption.

The resulting Kel-F[1] thermoplastic materials have a wide range of molecular weights: high-molecular-weight resins, used for molding and dispersions, are in the range of 300,000 and 400,000 units; lower-molecular-weight materials, existing as oils, greases, and waxes, have boiling points from −110° C. to about 230° C. at 1 mm. Hg. The lower-molecular-weight oils and greases are useful as plasticizers, stop-cock greases, damping fluids, etc.

Molding and extrusion materials: These are hard, dense thermoplastic resins with extreme chemical inertness, thermal stability, and high impact, tensile, and compressive strengths. The materials are supplied as high- or low-density molding powders.

The high-density molding powders are essentially ⅛-in. cylindrical pellets which have a compression ratio of 2:1. The low-density molding powders have a compression ratio of roughly 6:1 and are white, free-flowing powders.

Although there is a plasticizer grade and a flexible type for wire coating and thin-wall tubing, the molding and extrusion materials may be classed generally as rigid rather than as elastomeric plastics (Rockwell Hardness R111 to 115).

Plasticized materials are also available. The plasticizer has the same chemical and electrical properties as the high polymer.

The electrical characteristics of these molding and extrusion materials are also outstanding. The polymer does not carbonize when subjected to electrical arcing and withstands greater than 360 sec. when tested according to ASTM D495-42. Volume resistivity is outstanding over a wide temperature range. Its dielectric strength is 520 v./mil.

Dispersions: Dispersions were developed from polychlorotrifluoroethylene polymers to extend the protection of this material to surfaces that do not lend themselves to the use of molded plastic because of size, design, or construction.

These dispersions consist of finely divided particles of the high-molecular-weight plastic suspended in a volatile organic liquid. Upon heat fusion, the dispersions form a tough, permanent protective coating with all the properties of the original plastic. Dispersions can be applied to many metallic, and certain non-metallic surfaces by spray, spread or dip-coating. Primers are available to increase adhesion.

Antistick characteristics are an important advantage of fluorocarbon dispersion coatings. Glues, inks, paints, greases, meats, waxes, candies, rubber, or casting resins will not readily adhere. When used to coat surfaces of processing equipment, clean-out and shut-down time are reduced and schedules speeded up.

References

Consult the Subject Index for additional information concerning fluoroethylene. For information on injection molding, see p. 650; on compression molding, see p. 680; on extrusion, see p. 702. See also the Adhesives, Coatings, Films, Laminates, and Plastics Properties Charts for information on properties and trade designations. For sources of fluoroethylene resins, see Directory Index, p. 1018.

"How to apply and sinter fluorocarbon coatings," by G. Bartczak, MODERN PLASTICS *34*, 127 (Sept. 1956).

"Paste extrusion," by W. B. Thompson and R. E. Stabler, MODERN PLASTICS *33*, 115 (Feb. 1956).

"Small oil-free bearings," by H. S. White, J. Research NBS *57*, 185 (Oct. 1956).

"Thermal expansion of polytetrafluoroethylene (Teflon) from −190° to +300° C.," by C. R. K. Kirby, J. Research NBS *57*, 91 (Aug. 1956).

"Effects of fabrication on the properties of Teflon resins," by P. E. Thomas, J. F. Lontz, C. A. Sperati, and J. L. McPherson, SPE J. *12*, 89 (June 1956).

"Zytel and Teflon resins as bearing materials," by A. J. Cheney, W. B. Happoldt, and K. G. Swayne, Plastics Tech. *2*, 221 (Apr.); 314 (May 1956).

"Bonding qualities of Teflon improved," Materials and Methods *43*, 118 (Apr. 1956).

"Growing field for use of PTFE," Brit. Plastics *29*, 42 (Feb. 1956).

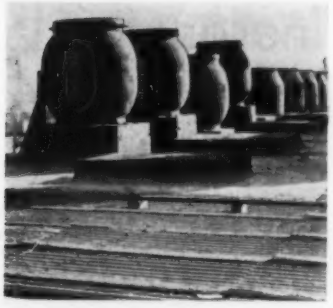
"Thermal decomposition of polytetrafluoroethylene in various gaseous atmospheres," by L. A. Wall and J. D. Michaelsen, J. Research NBS *56*, 27 (Jan. 1956).

* Chemical Manufacturing Div., Minnesota Mining & Mfg. Co., 75 Droyers St., Jersey City 3, N.J.

[1] Trademark of Minnesota Mining & Mfg. Co.

Furane Resins

BY JOHN DELMONTE*



Furane fan housings, 48 in. in diameter, remove acids and acid fumes from pickling tanks in plant. These fans have been installed for at least 10 years, show no sign of deterioration resulting from corrosive fumes or from the weather. (Photo, Haveg Corp.)

Recent Development

A furane-modified vinyl adhesive (*Resin* XV, Furane Plastics, Inc.) is used to bond metal name plates to wood, metal, and ceramic surfaces. The one-component, solvent-type adhesive is applied to the reverse side of the name plate and allowed to dry thoroughly. The name plate is momentarily heated to from 250 to 300° F. and pressed against the clean surface.

With the commercial development of the basic chemicals in the late '30's, furane resins began to make their appearance. Since that time they have become well known to the plastics industry, fulfilling special functions as heat- and corrosion-resistant thermosetting plastics. First they were utilized in conjunction with phenol in the manufacture of molding compounds, and then as polymers of furfuryl alcohol in adhesives and adhesive mortars.

Chemistry

The present industrial prominence of furane resins is due to the work of the late Dr. John Trickey and The Quaker Oats Co. in developing efficient methods for the extraction of furfural from pentosan-rich by-products (such as corn cobs, oat hulls, and —more recently—bagasse). Hydrogenation of furfural to furfuryl alcohol made available a compound capable of self-resinification in the presence of acid catalysts. Tetrahydrofurfuryl alcohol, water-white in appearance, has become valuable in the preparation of various esters for polyvinyl resins. Furan, another furane derivative, is most important commercially as the starting chemical used in the synthesis of commercial nylon. Tetrahydrofuran is one of the most active solvents for polyvinyl resins.

* President, Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

Recent Developments and References were prepared by the editors.

Furane cement is used to lay acidproof bricks to form lining for a large concrete tank. (Photo, Haveg Corp.)



Processes

A few of the more important processes using furane derivatives are as follows:

Furfural (also used as a partial replacement for formaldehyde) + phenol = molding compounds; furfuryl alcohol + dimethylolurea = low-shrink wood adhesives; furfuryl alcohol polymers = resin cements for acid bricks; furfuryl alcohol + formaldehyde = coatings and resin cements; furfuraldehyde + ketones = coatings and resin cements.

Outstanding properties

The properties of the furane resin compounds reflect the characteristics of the chemicals with which they have been reacted (i.e., phenol or urea). However, if pure furfuryl alcohol polymers are examined, the following qualities will be found in the resin:

1) Outstanding penetrating and impregnating qualities as a low-molecular-weight resin.

2) As a cured resin: a) excellent resistance to acids, alkalies, and solvents; b) good thermal stability and retention of strength and corrosion resistance at temperatures of 300 to 400° F.

3) Appearance: Dark, black colors characterize the cured polymers of furfuryl alcohol which cross-link rapidly into a tight, brittle structure.

Resins from furfuryl alcohol form liquid partial polymers and infusible and insoluble solids when reacted with heat and catalysts. Applications include:

1) Plaster of paris impregnants.

2) Cementing compounds for acidproof bricks when mixed with fillers.

3) Corrosion-resistant coatings which cure at low or moderate temperature.

Furfural-ketone resins will form soft solids which in turn will readily dissolve in solvents for use as coatings and adhesives. These have been used as modifiers for epoxy resins.

References

Consult the Subject Index for additional information concerning furane resins. See also the Adhesives and Coatings Charts for information on properties and trade designations. For sources of furane resins, see Directory Index, p. 1018.

"Furfural as a resin former," by E. A. Reineck, MODERN PLASTICS *29*, 122 (June 1952).

"Resin-forming reactions of furfural and phenol," by L. H. Brown, Ind. Eng. Chem. *44*, 2673 (Nov. 1953).

"New process for the manufacture of furfuryl alcohol resin intermediates," by E. R. Nielsen, SPE J. *9*, 10 (Feb. 1953).

Inorganic Plastics

Recent Development

A completely inorganic material (*Rosite "M"*, Rostone Corp.), which is cold molded at high pressures and subsequently cured in live steam at high pressure, provides marked arc-quenching under the action of an electric arc. The dielectric breakdown of this material is 60-80 v./mil; the flexural strength, 5000 p.s.i.; impact strength, 0.5 ft.-lb./in. (Charpy); heat resistance, 800° F.; and the water absorption of impregnated material is 0.5 to 1.0% after 24-hr. immersion.

GLASS-BONDED MICA AND THE CERAMOPLASTICS

BY J. H. DUBOIS*

One of the original inorganic plastics materials was glass-bonded mica, first produced in the United States in 1923. Glass-bonded mica is prepared by mixing freshly ground natural micas and a low-melting-point electrical grade of glass. This mixture is preheated until the glass becomes soft, then pressed to the desired shape by either of two methods—the compression molding process or the injection molding process.

For fabricating purposes, sheet and rod materials are formulated with a minimum amount of glass and a maximum amount of mica. A different combination is used to get a high plasticity material for molded products. High dielectric constant materials may be achieved by the inclusion of titanium dioxide or other titanates.

Glass-bonded mica molded products may be used at temperatures up to 650° F.; the fabricating material may be used at temperatures up to 700° F.

Included among the various other desirable properties are total arc resistance, radiation endurance, negligible moisture absorption, total dimensional stability, and freedom from distortion under age and thermal cycling. The thermal expansion coefficient matches closely the ferrous insert materials.

In processing these materials, proper proportions of mica and glass are mixed intimately with about 10% of water. The mixture is preformed under pressure of 4000 p.s.i. and dried to remove excess water. Compression molding is accomplished by heating preforms until the glass becomes plastic and then hot-pressing at 500 to 700° F. at approximately 4000 p.s.i. Most sections require careful annealing after molding.

Injection molding of glass-bonded mica is done by first preheating the charge, which is then manually transferred to the injection cylinder and injected into a closed mold maintained at a temperature of approximately 700 to 900° F. and at pressures from 10,000 to 50,000 p.s.i.

The ceramoplastic materials (Supramica 500, Supramica 555, Supramica 560)[1] are relatively new products composed of Synthamica, a pure, fluor-phlogopite synthetic mica, bonded with inorganic materials which enable them to be used in the 500° C. range for missile and supersonic aircraft components applications. The ceramoplastic materials also exhibit the moldability, the inclusion of inserts, and the ability to mold intricate detail not found in the true ceramic materials. The ceramoplastic materials have been subjected to a radiation dosage of 3.7×10^{18} gamma photons per sq. cm. and 1.7×10^{17} fast neutrons per sq. cm. with no change in dimensions, Rockwell hardness, and electrical resistance.

Included among the various other desirable properties that are important to the missile programs are a thermal expansion match with steel insert materials, absolute dimensional stability, no measurable moisture absorption, total arc resistance, improved machinability (compared with glass-bonded mica), and excellent electrical properties. The matching thermal expansion coefficient facilitates the inclusion of steel reinforcement for highly stressed sections.

*Mycalex Corp. of America, 125 Clifton Blvd., Clifton, N. J.

Recent Developments and References were prepared by the editors.

TABLE I: Properties of glass-bonded mica[1]

Property	*Value*
Dissipation factor, 1 megacycle	0.0035
Dielectric constant, 1 megacycle	6.8
Loss factor, 1 megacycle	0.024
Volume resistivity, ohm-cm.	5×10^{13}
Specific gravity	2.8
Maximum operating temperature	
Continuous, °F.	932
Short time, °F.	1100
Water absorption, % in 24 hr.	Nil
Hardness, Rockwell M	125
Thermal expansion, per °C. at 20° C.	13×10^{-6}
Flexural strength, p.s.i.	15,000

[1] Based on Supramica 560 ceramoplastic.

References

See the Plastics Properties Chart for information on properties and trade designations. For sources of inorganic plastics, see Directory Index, p. 1018.

"Cold molding materials may solve your plastics selection problems," by B. F. Hantz, Electrical Mfg. *39*, 80 (July 1947).

"Glass-bonded mica—its development and use," by A. Monack, Elec. Mfg. *38*, 106 (Nov. 1946).

[1]Trademarks of Mycalex Corp. of America.

Ion Exchange Resins

BY ROBERT W. PERCIVAL* and ALVIN G. WINGER*

RECENT DEVELOPMENTS

Radioactive contaminants may be removed from water by the addition of commercially available ion exchange resins. The Sanitary Engineering Branch of the Corps of Engineers' Research and Development Laboratories says the treatment makes water suitable in 30 min. for emergency drinking.

A new process for "in-situ" epoxidation with cation exchange resin catalysts makes continuous flow column techniques practical for the first time (Becco Chemical Div., Food Machinery & Chemical Corp.). The process overcomes resin attack, thus substantially extending the working life of the resin as well as retaining its catalytic action.

A new series of ion exchange resins for use in chromatographic analysis (*CG*, Rohm & Haas Co.) is chemically identical to standard and analytical grade (*Amberlite*) exchangers, but the particle size is more uniform. One type, with a particle size between 100 and 200 mesh, separates materials with appreciably different chemical properties by a combination of ion exchange and adsorption. A second type has a particle size that passes 200 mesh (dry), offers greater rate of reaction, and permits sharp separation of closely related chemicals.

A highly cross-linked polystyrene, sulfonic acid-type cation exchange resin (*Amberlite IR-124*, Rohm & Haas Co.) is designed to give longer operating life under strong oxidizing conditions. It is recommended for use in applications involving the treatment of solutions such as plating wastes, anodizing baths, etc.

A phenomenal growth in the field of ion exchange has taken place since the first synthetic organic exchange resins appeared on the chemical scene over twenty years ago. Today the synthetic organic resins have completely overshadowed the older types of inorganic exchangers.

The reasons for this development are the much wider variety of exchange groups that can be introduced into the organic resins, the possibility of obtaining, at will, differing degrees of porosity, and the greater chemical and physical stability of the organic exchangers under extremes of acidity and alkalinity.

Ion exchange resins may be classified as cation exchangers with either strongly or weakly acidic functional groups and anion exchangers which contain either strongly or weakly basic functional groups.

* Rohm & Haas Co., Washington Sq., Philadelphia, Pa.

Recent Developments and References were prepared by the editors.

Ion exchange reactions

The important reactions of these resins are shown in the schematic equations in Fig. 1, p. 125, in which "R" represents the insoluble organic resin skeleton to which the hydrophilic functional groups are attached.

All of the many types shown are capable of entering into the neutralization reaction, but this reaction is reversible by hydrolysis in the case of the weak acid or weak base resins. Second, all of the resins will exchange ions of one species for others of the same species, excepting the special cases of hydrogen and hydroxide ions. The reversibility of these reactions by means of changing the concentration of the solution contacting the resin is, of course, the feature that permits the economical employment of these materials in so many processes. Third, only the strong acid and base exchangers can "split neutral salts," liberating in the one case a strong acid, in the other case setting free a strong alkali.

There are several other fundamental chemical properties that are not revealed by the schematic equations that are listed in Fig. 1.

For example, ion exchange resins generally show different affinity for adsorbing different ions. Thus, for cation exchangers, ions of higher valence tend to replace ions of lower valence ($Th^{++++} > Al^{+++} > Ca^{++} > Na^{+}$) and ions of higher atomic number tend to replace ions of lower atomic number ($Cs^{+} > Rb^{+} > K^{+} > Na^{+} > Li^{+}$).

Another important property of ion exchange resins is their porosity. In order to make full use of all of the functional groups in a resin particle, it is obviously necessary to have pores large enough to permit the ions to diffuse into them.

The regular grades of ion exchange resins are sufficiently porous to admit all the ordinary inorganic ions. But there are certain applications involving large organic ions that require resins of unusually high porosity. The question of the means by which porosity may be controlled leads logically to a consideration of the methods of manufacture by which current resin types are produced.

Manufacture

The most important of the present-day ion exchange resins are made by copolymerizing styrene with a cross-linking agent such as divinylbenzene (DVB) and subsequently reacting this skeleton with agents that will introduce the desired functional groups, or by copolymerizing compounds already containing functional groups with cross-linking agents. Examples of the first procedure are sulfonation of the styrene DVB skeleton to yield

cation exchangers or chloromethylation followed by amination to yield anion exchangers. Examples of the second procedure are copolymerization of methacrylic acid with DVB or of maleic anhydride and styrene with DVB to yield weak acid cation exchangers.

There are still on the market today some very important ion exchange resins which are based on phenol-formaldehyde, aminobenzene-formaldehyde, or nitrogen heterocycle-formaldehyde condensates.

In all cases, control of the degree of porosity is possible. With the vinyl polymers, this is accomplished by regulating the amount of cross-linking agent; with the condensates, by the amount of formaldehyde used, or inert extenders can be added to both.

Still another important consideration with ion exchange resins is particle size and size distribution since these affect the rate of exchange and the hydraulic properties of the system. The vinyl copolymers are advantageously prepared by suspension polymerization which permits control of particle size. The condensation products are usually prepared in bulk and subsequently ground and sieved to the desired sizes.

Equipment and operation

By far the most general use of ion exchange resins is in column operation. That is to say, the resins are employed as fixed beds in suitable containers and are contacted by the solution that is to be treated as it flows through the bed.

After the resin has adsorbed all of the ions that it is capable of adsorbing under the conditions employed, it is regenerated by passing through the bed a more concentrated solution of a reagent that will return it to its original ionic form. Ion exchange processes are carried out on a laboratory scale in pipets, burettes, or small-diameter columns and on an industrial scale in tanks which are of sufficient size to hold several hundred cubic feet of ion exchange resin. Two other types of operation are being used in certain special instances.

A continuous ion exchange process is possible using moving beds of resin which are transferred by means of eductors from the exhausting chamber and recycled but this is a complex and expensive operation.

The other kind of operation is batchwise. In certain ore-treating processes, baskets of large particle size resin are dipped into slurries (or pulps) of the finely divided ore suspended in a leaching solution until the resin is saturated with the desired ion. The baskets are then removed and regenerated in another batchwise step. This batch-type operation is generally referred to as the resin-in-pulp process.

Applications

The largest amounts of ion exchange resins are currently being used in water conditioning.

There are two important processes in this field: 1) softening, i.e., the exchange of sodium for calcium and magnesium ions using cation exchangers; and 2) deionization, i.e., the removal of all ions using both cation and anion exchangers, either successively in two separate beds or simultaneously in a Monobed (mixed bed). Strong base resins in the hydroxide form will remove even silica, and highly porous strong base resins will remove organic matter, so that water of extremely high purity can be produced by means of these exchangers.

Other applications in the fields of waste treatment, metal recovery, food processing, analysis, industrial processes, catalysis, and so on, have been described in reference works and reviews.

Uranium recovery

Ion exchange resins are also indispensable in the recovery of uranium from ores in which it occurs in very low concentrations. These ores are leached with sulfuric acid or sodium carbonate solutions to produce a very dilute solution of complexed uranium anions which can be separated by conventional methods only with great difficulty. However, adsorption of the anion complex, such as $UO_2(SO_4)3^{-4}$ or $UO_2(CO_3)3^{-4}$, on strongly basic anion exchangers in the sulfate form and subsequent elution with nitrate or chloride solutions results in 50- to 100-fold concentration of the uranium originally present in the leach liquor. Precipitation processes can now be used to recover the uranium from the concentrated solution.

Certain uranium-bearing ores upon leaching produce slurries that are difficult to filter and hence unsuitable for passage through ion exchange columns. In order to recover the uranium from such liquors, an adsorption system, mentioned earlier, known as the resin-in-pulp method, is employed. In this system, baskets containing large particle size ion exchange resins are contacted with the slurry by mechanical agitators and the resin eluted after sufficient adsorption has occurred. Various schemes for continuous columnar ion exchange are also under development for the recovery of uranium. By the above techniques, at least 99% of the uranium in the leach liquors can be recovered as a concentrate having a U_3O_8 content greater than 70 percent.

Sugar refining

Rising standards of quality in crystalline and liquid sugars in this country have given impetus to the interest in ion exchange resins for the refining of sugar. Because of their ability to remove both ash and color bodies from sugar sirups, ion exchange resins can improve in striking fashion the final quality of liquid or crystalline sugars.

Raw cane sugar is generally put through the following refining steps: a water wash to remove molasses clinging to the crystals; solution in water followed by treatment with lime and phosphoric acid; filtration and passage through bone char and/or vegetable carbon. Several batches of white crystalline sugar can then be obtained from the sirup before the mother liquor must be returned to the refining cycle. The use of a highly porous strong base anion exchanger in the chloride form following a vegetable-carbon treatment removes additional color and sulfate ions, making it possible to obtain one or two extra crystallizations of white sugar. A smaller than nor-

mal quantity of vegetable carbon may be used and more expensive bone char completely eliminated. The resin is regenerated, for the most part, simply with salt, although occasional treatments with sodium hypochlorite to remove adsorbed color bodies are also employed. The extra "strikes" of crystalline sugar thus obtained and the savings in initial cost of bone char and rejuvenation steps required when the bone char is exhausted are very important to the sugar refiner.

In the production of liquid sugars, there is, of course, no crystallization step and it is necessary to use a mixed cation and anion exchange resin bed to de-ionize as well as to decolorize the sirup. The resins to be used in the de-ionization of the sirup depend on the type of sirup desired, whether sucrose or invert. If the latter is desired, a strongly acidic cation exchange resin in the hydrogen form together with a porous strongly basic anion exchanger is used in the mixed bed. If inversion is to be avoided, as in the case of production of sucrose sirup, a weakly acidic cation exchange resin is used instead of the strongly acidic resin.

Exchange resins are also used to refine dextrose and beet sugar.

Strong acid cation exchanger

Neutralization

$$RSO_3H + Na^+ + OH^- \rightarrow RSO_3Na + H_2O$$

Cation exchange

$$2\ RSO_3Na + Ca^{++} + 2\ Cl^- \leftrightharpoons (RSO_3)_2Ca + 2\ Na^+ + 2\ Cl^-$$

Neutral salt splitting

$$RSO_3H + Na^+ + Cl^- \leftrightharpoons RSO_3Na + H^+ + Cl^-$$

Weak acid cation exchanger

Neutralization

$$RCOOH + Na^+ + OH^- \leftrightharpoons RCOONa + H_2O$$

Cation exchange

$$2\ RCOONa + Ca^{++} + 2\ Cl^- \leftrightharpoons (RCOO)_2Ca + 2\ Na^+ + 2\ Cl^-$$

Neutral salt splitting

$$RCOOH + Na^+ + Cl^- \rightarrow \text{Virtually no reaction.}$$

Strong base anion exchanger

Neutralization

$$RN^+(CH_3)_3OH^- + H^+ + Cl^- \rightarrow RN^+(CH_3)_3Cl^- + H_2O$$

Anion exchange

$$RN^+(CH_3)_3Cl^- + 2Na^+ + SO_4^= \leftrightharpoons [RN^+(CH_3)_3]_2SO_4^= + 2Na^+ + 2Cl^-$$

Neutral salt splitting

$$RN^+(CH_3)_3OH^- + Na^+ + Cl^- \leftrightharpoons RN^+(CH_3)_3Cl^- + Na^+ + OH^-$$

Weak base anion exchangers

Neutralization

$$RN^+H_3OH^- + H^+ + Cl^- \leftrightharpoons RN^+H_3Cl^- + H_2O$$

Anion exchange

$$2RN^+H_3Cl^- + 2\ Na^+ + SO_4^= \leftrightharpoons (RN^+H_3)_2SO_4^= + 2\ Na^+ + 2\ Cl^-$$

Neutral salt splitting

$$RN^+H_3OH^- + Na^+ + Cl^- \rightarrow \text{Virtually no reaction.}$$

Fig. 1: Schematic equations of some important ion exchange resin reactions

Pharmaceutical

Powdered ion exchange resins are used in therapeutic oral and topical drug preparations. Weakly basic anion resins are available in the form of tablets, powders, or suspensions for use in ulcer therapy and as antacids. A weakly acidic carboxylic cation resin gained widespread importance as an effective means of controlling cardiac edema through sodium reduction. More recently, sustained release oral compounds, employing various ion exchange resins as carriers for such drugs as *p*-aminosalicylic acid, amphetamine, etc., have been introduced. In many instances, the use of exchange resins as carriers provides a means of lowering the threshold of irritation of certain drugs which produce undesirable side reactions when administered in their free form.

A micropowdered exchange resin or combination of resins can be used in skin creams, lotions, and powders as a means of maintaining the natural acid mantle factor of the human skin and normal skin health. The strong absorption affinity of exchange resins for low-molecular-weight fatty acids and protein degradation products has stimulated interest in the development of antiperspirant-deodorant preparations employing small concentrations of exchange resins. Clinical evidence indicates advantages in lack of irritation as well as longer protection.

References

Consult the Subject Index for additional information on ion exchange resins. For sources of ion exchange resins, consult the Directory Index, p. 1018.

"Ion exchange resins," MODERN PLASTICS *31*, 228 (Feb. 1955).

"Ion exchange in the atomic energy program," by Robert Kunin and Albert F. Preuss, Ind. Eng. Chem. *48*, 30A (August 1956).

"Future of ion exchange in sugar refining," by Harold E. Weaver, Sugar (July 1956).

"Potential utility of ion exchange resins in antiperspirant-deodorant formulations," by James C. Winters, J. Soc. Cosmetic Chemists *7*, (May 1956).

"Review of fundamental developments in analysis: ion exchange," by R. Kunin, F. X. McGarvey, and A. Farren, Analytical Chemistry *28*, 729 (April 1956, Part II).

"Unit operations in chemical engineering: ion exchange," by R. Kunin, F. X. McGarvey, and A. Farren, Ind. Eng. Chem. *48*, 540 (Mar. 1956).

"Ion exchange," by R. Kunin and F. McGarvey, Ind. Eng. Chem. *47*, 565 (1955).

Isocyanate Resins

BY J. H. SAUNDERS* and R. C. BURCK**

RECENT DEVELOPMENTS

A polyaryl polyisocyanate (*Papi*, Carwin Co.), is expected to find extensive use in increasing the resiliency and raising the heat distortion point of flexible and rigid urethane foams. An *n*-butyl isocyanate (*Bunco*, Carwin Co.) is expected to find application in various phases of the textile field, such as waterproofing fabrics, increasing wear resistance of wool, and in tanning hides.

Flexible urethane foams are now being prepared from diisocyanates and polypropylene glycols of several types. The new foams have three main advantages over conventional diisocyanate-polyester foams: they can be more readily molded; they can be made in much softer grades; and they have better resistance to accelerated aging conditions of combined heat and high humidity. These improvements in properties should greatly expand present markets and should bring urethane foams into many new fields of application.

A new polyisocyanate has been developed to overcome one of the principal limitations to the use of urethane coatings. Most urethane coatings were previously based on formulations containing some free tolylene diisocyanate, which is a respiratory irritant. The new polyisocyanate (*Mondur CB*, Mobay Chemical Co.) contains less than 1% of free tolylene diisocyanate, and consequently can be handled much more freely than previous related materials.

Much better temperature resistance than was previously possible with urethane wire enamels has resulted from the combination of a new disguised or blocked polyisocyanate and a new polyester (*Mondur SH* and *Multron F-38*, respectively, Mobay Chemical Co.). While the enamel based on these materials is not readily solderable, it is expected to find use in many applications for which performance in the 150 to 180° C. range is desired.

A magnet wire insulation material for use on solderable wire is based on a combination of polyvinyl formal (*Formvar*, Shawinigan Resins Corp.) and urethane. This combination gives exceptional coatings with respect to solderability at low temperatures, resistance to thermoplastic flow, low extractible content, and resistance to softening by refrigerant Freon 22.

Isothane polyurethane stripper (Surface Chemicals, Inc.), a noncorrosive solvent-type stripper, has been developed to promote the removal of polyurethane reaction products from ferrous and nonferrous metals. Applied by dip, flow coat, brush, or spray, its action is complete after a short contact period. Simple solvent wash after stripping will give recoatable surfaces.

Isocyanate resins, also known as "polyurethane" or simply "urethane" resins, are an outgrowth of research in Germany and in the United States since 1937. They have approached commercial production here only within the past year. The major fields of use include flexible and rigid foams and coatings; adhesives and synthetic elastomers are still in the development stage, but show great promise.

The isocyanates of greatest commercial importance are the diisocyanates; of these, tolylene diisocyanate is most widely used. A variety of compounds containing two or more "active hydrogen" groups, e.g., hydroxyl, amino, and carboxyl, may be used to react with the diisocyanates to produce polymers. The most widely investigated compounds for reaction with diisocyanates, and the principal ones used on a commercial scale at this time, are the polyesters. These polyesters are generally liquids of moderate molecular weight, e.g., 1000 to 2500, and terminate principally in hydroxyl groups. The polyesters vary greatly in their degree of branching, the desired final polymer properties determining the degree of branching used. Linear polyesters usually lead to elastic polyurethanes, whereas highly branched polyesters give rigid polyurethanes. Essentially any degree of rigidity or flexibility may be obtained by the proper choice of reactants.

Chemistry

In reacting with the polyesters, the diisocyanates $[R(NCO)_2]$ combine with hydroxyl groups in the polyester $[R'(OH)_2]$, joining polyester molecules together with urethane linkages as shown in Formula 1, p. 127.

For applications in which films, solid plastics, or solid elastomers are desired, this is the principal reaction. However, when a foam is desired, an excess of diisocyanate and water are added. In this case the diisocyanate serves both as a cross-linking agent and as a blowing agent. The reaction with water furnishes the gas for foaming, as is illustrated for a monoisocyanate below:

$$2\ RNCO + H_2O \rightarrow RNHCONHR + CO_2$$

In addition to the polyesters, simple glycols, polyethers, castor oil, drying oils, and a host of other polyfunctional materials have been treated with diisocyanates to prepare useful products. Monoisocyanates have also been

* Assistant Director, Research Dept., Mobay Chemical Co., New Martinsville, W. Va.
** Development Dept., Mobay Chemical Co., 1900 S. 2 St., St. Louis, Mo.
Recent Developments and References were prepared by the editors.

used for a variety of applications, including waterproofing textiles and leather, and as chemical intermediates in the drug industry.

Foams

Development of soft, flexible, and rigid urethane foams has continued at an accelerated rate.

These urethane foams, whether flexible or rigid, most often are prepared commercially from polyesters, diisocyanates, and water. The mechanical characteristics of the foam depend largely on the choice of polyester. By varying the degree of branching, either flexible or rigid foams can be prepared. The diisocyanate reacts with the polyester, converting that low-molecular-weight liquid polymer into a high-molecular-weight elastomer or plastic. At the same time the diisocyanate reacts with water to generate carbon dioxide, which foams the resin. The density of the foam is controlled by the amount of water and the corresponding amount of diisocyanate used.

In addition to these major ingredients, other agents such as catalysts and emulsifiers may be added to control the rate of foaming and the cell structure of the foam. All ingredients may be mixed at one time, using good agitation. Just as the evolution of gas begins, the liquid mixture is poured into the mold or cavity to be filled, and the foaming reaction will proceed without the application of heat or pressure. The foaming recipe must be carefully adjusted to provide gas evolution at a suitable rate and before gelation occurs. The time and degree of mixing of the ingredients must be closely controlled. The preparation of flexible foams requires 25 to 50 parts of diisocyanate per 100 parts of polyester, while rigid foams usually require 60 to 100 parts of diisocyanate. Lighter foams of either type require more diisocyanate than do the denser foams.

Two-component systems are available for hand mixing in the field, but most production involves the simultaneous machine mixing of all ingredients immediately before foaming. One of the most important developments in the field of urethane foams is the design of suitable machinery for the continuous production of foam of outstanding quality and uniformity of structure. Blocks of flexible foam up to 80 in. wide, 25 ft. long, and 10 in. high are being produced. Spray-gun type and intermittent foaming equipment are also being developed.

An outstanding advantage of the urethane foams is that they can be "foamed in place" without the application of heat or pressure. The foam rises, completely filling irregular cavities, and bonding well to the walls of the container. The foaming reactions are exothermic and of sufficient driving force to complete the curing of the foam. This advantage is of special value in the use of rigid foams for structural and insulation purposes, where great savings in labor may be realized. It also is useful in the foaming of shaped articles in molds, using flexible or rigid foams.

$$R(NCO)_2 + R'(OH)_2 \rightarrow \left[R\text{–}NHCO\text{–}R'\text{–}OCNH \right]_x$$

Formula 1: Polyester molecules joined together with urethane linkages

Flexible foams having a predominantly open-cell structure are available in a density range of 2 to 6 lb./cu. foot. Foam may be prepared in a variety of colors, and may easily be produced so that it will not support combustion. Mechanical properties are such that a 2.5 lb./cu. ft. urethane foam (see Table I, p. 128) is superior to a medium-density latex foam in load-bearing characteristics and tensile strength.

The combination of properties shown makes flexible urethane foam excellent for cushioning uses. The flame-resistant characteristics make it especially attractive for use in public meeting places, transportation vehicles, and hotels. The high tensile strength and tear- and abrasion-resistance are very desirable for such uses as toys, sponges, and gaskets. Its open-cell structure and good sound absorption, flame resistance, and the ease with which it is spray-painted forecast its use for acoustical insulation.

Rigid urethane foams are available in a density range of 2 to 30 lb./cu. ft., and have predominantly closed cells. A variety of rigid foams are available having different mechanical properties. Compression and tensile strength of typical rigid foams are shown in Table II, p. 128.

In addition, the adhesion to container walls, and impact and vibration resistance of rigid foams are excellent. The dielectric properties, chemical resistance, and thermal conductivity properties are good. The maximum temperature for use is high, 150° C. for a standard 12 lb./cu. ft. foam.

These properties of the rigid foams make them attractive for applications requiring simplicity of processing equipment, good mechanical strength, temperature and vibration resistance, and closed-cell structure. These products have been used extensively in the aircraft industry for filling cavities in radomes, ailerons, rudders, elevators, wing tabs, and for insulating cabin ventilating systems. Other uses of importance include the construction of nonsinkable boats and pontoons. Applications in the field of insulation, as in houses and refrigerators, are being explored.

Coatings

Urethane coatings are now being used on a commercial scale in applications where the combination of their unusual properties has made them immediately acceptable. They are formulated with partially reacted isocyanates (adducts) and are used both in one- and two-component systems. The one-component coatings are made with a "blocked" isocyanate and at room temperature are stable; at elevated (bake) temperatures the blocking agent is

TABLE I: Mechanical properties of a typical 2.5 lb./cu. ft. flexible urethane foam

Property	*Value*
Indentation strength, 25% indentation, lb./50 sq. in.	10-60
Compression set, 158°F., maximum[1] %	5-10
Tensile strength, p.s.i.	15-30
Tear strength, lb./in.	4-6
Elongation, %	180-300

[1]Based on original height.

driven off and the isocyanate is available for reaction. Two-component systems have a practical work or container life of 24 to 48 hr. after mixing, and this can be extended still further by certain storage and mixing procedures; they will cure at room temperature but can be accelerated by use of heat. Like urethane foams, the chemical and physical properties of the coatings are dependent to a large degree on the choice of polyester.

Both the clear and pigmented urethane coatings produce hard, high-gloss surfaces in an air-dry system. They develop excellent adhesion to almost all surfaces. The extensive use of these coatings in Europe has shown them to have good abrasion- and impact-resistance as well as chemical, solvent, fresh and salt water, and moisture resistances, and good weathering properties. Use in this country has confirmed their excellent dielectric properties.

Elastomers

Similar to the flexible foams, solid elastomers are being prepared from linear polyesters and an excess of diisocyanate. Unlike the foams, however, the elastomers are usually prepared without catalysts and emulsifiers, and only a low concentration of water, if any, is used. Some agent such as water, a glycol, an amino alcohol, or a diamine is used in small amounts to insure adequate urethane or urea groups, which are potential points for cross-linking with the excess of diisocyanate.

Two different techniques are used for preparing the elastomers. In one—the "casting process"—all ingredients are mixed within a very short time, and the liquid mixture is poured into a mold and cured. In the other—using a "storage stable" intermediate elastomer—a material somewhat resembling raw rubber is prepared, using an amount of diisocyanate that is insufficient for complete cure. The product thus formed is stable, and can be cured by treatment with more diisocyanate.

The isocyanate-polyester rubbers have outstanding abrasion- and tear-resistance, as well as excellent tensile strength, ozone resistance, and oil resistance. They have moderate resistance to dry heat, but are limited in their resistance to extremes of temperature, hot water, acids, and alkalies. Like the other isocyanate products, these elastomers are available in a considerable range of hardness and other properties.

Appropriate grades of these elastomers are being used in Europe in applications such as solid tires, gears, conveyor belts, shoe heels, gaskets, handles for air hammers, pump linings, etc. Investigations in this country have been directed more toward use in car tires.

Adhesives

Isocyanate resins have been used quite extensively in formulating adhesives for the rubber industry. Used by themselves and as additives to rubber-based adhesives, the isocyanates promote excellent adhesion to both metallic and nonmetallic surfaces.

The principles described in the preparation of urethane coatings can also be applied to urethane adhesives.

References

Consult the Subject Index for additional information concerning isocyanate resins and polyurethanes. See also the Adhesives and Foamed Plastics Charts for information on properties and trade designations. For sources of isocyanate resins, see Directory Index, p. 1018.

"Polyurethanes on the way," MODERN PLASTICS *32*, 102 (Aug. 1955).

"Polyurethane resins," by J. Bjorksten, H. Tovey, and H. L. Dollard, Jr., MODERN PLASTICS *31*, 143 (Apr. 1954).

"Urethane coatings go down to the wire," Chem. Week *78*, 60 (May 5, 1956).

"Urethane rubber from a polyether glycol; properties of raw polymer and vulcanizates," by F. B. Hill, C. A. Young, J. A. Nelson, and R. G. Arnold, Ind. Eng. Chem. *48*, 927 (May 1956).

"Preparation, properties, and applications of isocyanate products," by W. E. Kenline and R. D. Hirschbeck, Plastics Tech. *2*, 168 (Mar. 1956).

"Isocyanate resin-coated glass cloth insulation," by H. G. Steffens, Electrical Mfg. *57*, 114 (Jan. 1956).

"Current developments in foamed polyurethanes," Brit. Plastics *29*, 5 (Jan. 1956).

"Some uses of polyurethanes in electronics and surface coatings," by J. Brennan, Brit. Plastics *28*, 417 (Oct. 1955).

"Isocyanate-base polymers," by I. Katz, Materials and Methods *42*, 84 (Aug. 1955).

TABLE II: Mechanical strength of rigid urethane foams

Density	*Compressive strength*	*Tensile strength*
lb./cu. ft.	*p.s.i.*	*p.s.i.*
3	40-50	75-85
6	120-160	170-190
9	240-280	280-300
12	400-440	400-420

Natural Resins

The natural resins constitute a continuous series of solid, nontoxic, film-forming gums varying over a broad range of solubilities and hardness. Named for their source of origin, in most cases, they are classified into four major groups, as follows: 1) Damars; 2) East Indias: batu, black, pale; 3) Copals: manila, pontianak, kauri, congo; and 4) Miscellaneous: accroides, elemi, mastic, sandarac.

Almost all of the natural resins are simply cold-cut in solvents where they are generally compatible with substances soluble in the same materials. Many of the resins are oil-soluble in their raw state, while others (congo, black and pale East Indias, kauri) are prerun at high heats. A range of grades is available in all of the varieties.

Damars are versatile resins, having adhesion, depth of gloss, color, gloss retention, miscibility, and resistance to scuffing, greases, and cold checking. "Dewaxed" Damar is a lacquer resin.

East Indias are related to the Damars. Batu is a high-melting-point resin with greater viscosity, water resistance, and weather resistance. It has fast solvent release, and compatibility with stearic acid and a wide range of oils, waxes, resins, asphalts, pitches, chlorinated rubber, and cellulose derivatives. Uses include varnishes, inks, adhesives, and composition products. Black East India makes an opaque varnish that dries to a light color. It provides tough varnishes for metals and wood with water resistance, adhesion, and flexibility. Pale East India yields greater control of sheen. Its resistance to temperature changes and water makes it useful in special-purpose varnishes.

Copals: Manilas are broadly used in alcohol solutions for varnishes, printing inks, adhesives, liquid waxes, compositions, and specialty products; gloss, color retention, and flexibility give it broad usage. *Pontianak* is similar to the manilas but of higher melting point. *Kauri* has long been used as a basic varnish resin. Certain grades are alcohol-soluble. This is a fossil resin. *Congo* is insoluble in its original state. Processed, it can be adapted to broad uses in varnish coatings in which toughness, flexibility, adhesion, color, and gloss retention are desired. Metal coatings, floor varnishes, enamels, wrinkle finishes, and furniture varnishes are some of its outlets.

Accroides (red, yacca) is a specialty resin with thermosetting qualities. Its red color is inseparable. *Elemi* is a plasticizing resin used in varnishes, lacquers, caulking compounds, and specialty coatings. *Mastic* and *sandarac* are specialty resins used in artistic fields.

Amber: This yellowish, transparent-to-translucent, fossil resin is derived from an extinct conifer. It takes a polish well and is the hardest known natural resin. However, it is brittle and breaks with a conchordal fracture.

Shellac: This natural resin is produced by tree lice *(Tacoardia lacca)* found in Asia. Shellac exhibits characteristics of both thermoplastic and thermosetting types of binders, retaining its thermoplasticity for a long period when heated. Heat-curing increases the mechanical and electrical strength of the material.

Rosin: This product of pine tree exudations consists largely of abietic acid, together with other complex terpenic acids and esters. It has not been used extensively in molding compositions because of its low softening point and brittleness.

Vinsol[1] is another product of the steam distillation process by which naval stores are extracted from the wood of the long-leaf Southern pine. It is an ideal modifier for most natural and synthetic resins. High-melting materials or thermosetting condensates are produced by reacting the resin with aldehydes. It is soluble in alcohols, esters, cyclic hydrocarbons, and chlorinated solvents, possesses high dielectric strength, a low power factor even at high temperatures, and has the ability to withstand high-voltage electrical impulses.

[1] Trademark of Hercules Powder Co.

Asphalts: These are naturally-occurring hydrocarbon complexes, termed bitumens, which are insoluble in water, but soluble in carbon disulfide and benzene. The amorphous brownish to black mixtures range from mobile fluids to hard friable solids. Asphalts can also be processed to yield products with a wide range of physical properties such as good dielectric properties and resistance to moisture, acid, alkali, and most chemicals.

Cashew resins: The cashew nut is obtained mainly from India. The heat-reactive-type resins formed by condensation of the cashew phenols with aldehydes are available in the form of mobile liquids, viscous liquids, powdered fusible solids, granular infusible solids, and rubbery infusible solids. Typical applications for these cashew nutshell liquid resins are adhesives, phenolic resin plasticizers, potting compounds, protective coatings, rubber compounding, and synthetic drying oils of an extreme degree of alkali resistance; they also find use in automotive and other brake linings.

References

Consult the Adhesives and Coatings Charts for information on properties and trade designations. For sources of natural resins, see Directory Index, p. 1018.

"Applications of cashew nutshell liquid resins," by E. M. Evans, Rubber and Plastics Age *36*, 278 (May 1955).

"A low-cost injection molding material," by K. Rose, Materials and Methods *40*, 144 (Oct. 1954).

"Asphalt and allied substances," by H. Abraham. 1945. New York: D. Van Nostrand Co.

"The technology of natural resins," by C. L. Mantell, C. W. Kopf, J. L. Curtis, and E. M. Rogers. 1942. New York: John Wiley and Sons, Inc.

Nylons (Polyamides)

RECENT DEVELOPMENTS

A new nylon resin (*Zytel 42*, Du Pont) has a viscosity tailored for use in extrusion equipment. Its applications include tubing for an automobile lubrication network which the motorist can actuate by pushing a button; as an actuator rod moving inside a retractable auto radio antenna; washers; aircraft grommets; and bearings. The material has also been blow molded to produce aerosol containers.

An improved polycaprolactam-type nylon (*Plaskon Nylon 8201*, Barrett Div., Allied Chemical & Dye Corp.) extends the range of products fabricated from nylon, particularly clear film and small-diameter tubing and rod. The new material is characterized by its low moisture content, wide range of permissible stock temperatures, and relatively high molten viscosity, resulting in improved moldability and extrusion, lower processing temperature, minimized shrinkage in thick sections, and elimination of voids.

Molybdenum disulfide-filled nylon thrust washers (*Nylatron GS*, The Polymer Corp. of Pennsylvania) are used where good wear resistance under light thrust conditions is required. The filled nylon formulation has better dimensional stability and lower deformation under load than standard nylon, coupled with a lower coefficient of friction and higher wear resistance.

Nylon pipe (*Tempertube*, The Danielson Mfg. Co.) is claimed to provide greater bursting strength and higher heat resistance than other plastics pipe of comparable dimensions. The pipe is supplied in straight lengths or continuous coils in sizes from ⅜ to 1½ in. O.D. with wall thicknesses from 0.025 to 0.125 inch.

An epoxy-based compound (*Bonding Agent R-323*, Carl H. Biggs Co.) designed to bond nylon to itself, to metal, or to other materials possesses high bond and peel strength. It may also be used with rubber.

Extruded blown-flat nylon tubing and heat-sealed bags are being produced from type 6 nylon (Kemtek Corp.). The film withstands either steam or dry sterilization in an autoclave with no loss of physical properties, resists most solvents, and is sealable by heat or high frequency. It resists the passage of oxygen and other gases and liquids, while allowing slight transfer of water vapor.

Nylons are polymeric resins, formed by the condensation of dibasic organic acids with diamines into linear chains containing amide groups. They were developed in the classic researches of W. H. Carothers and introduced on the market in 1938 in the form of bristles and hosiery fibers. The inherent properties of the materials, however, such as strength, toughness, ability to withstand high temperatures, abrasion resistance, and good chemical resistance made it quickly apparent that a potential existed as an industrial molding powder. Consumption of nylon powders for this purpose has increased considerably over the past few years.

Table I, p. 132, lists the various types of present-day commercial nylons, showing the chemical raw materials used to make them and the properties that are imparted by them to the different nylons listed.

This article is based on information supplied by E. I. du Pont de Nemours & Co., Inc.; Spencer Chemical Co.; Barrett Div., Allied Chemical & Dye Corp.; Foster Grant Co., Inc.; and The Polymer Corp. of Pa.

Properties

Within the wide range of nylons available, the three most important types of nylon are nylon 6/6, nylon 6, and nylon 6/10. Nylon 6/6 (so-called because both the acid and amine used in making it contain 6 carbon atoms) is the most common and oldest type of nylon. Nylon 6, a newer material, is a polymer made by opening the ring of caprolactam, a 6-carbon condensed amide, and reportedly has a higher impact strength, is easier to mold, and more flexible than nylon 6/6. Nylon 6/6, however, is harder, has greater abrasion and heat resistance, and shorter molding cycles.

In the manufacture of the third major type of nylon, 6/10, sebacic acid is substituted for the adipic acid component to yield a softer, tougher, more resilient polymer with lower water absorption.

Over-all, however, the common 6/6 and 6 nylons have fitted into their important and rapidly growing uses because of a unique combination of desirable properties. They are stiff, strong, tough, light, abrasion-resistant, and self-extinguishing, have a low coefficient of friction, and are chemically and thermally resistant. Such properties, plus their ability to be accurately molded into intricate shapes, have fitted them for mechanical and other critical applications where they either replace less satisfactory or more expensive metal parts or do jobs previously not possible. While wear properties are improved by lubrication, nylon moldings give excellent service with no lubrication under many service conditions and will frequently outwear corresponding metal parts. Nylon's chemical resistance is particularly valuable where electrolytic action corrodes metal parts, particularly where a bimetallic junction is involved. Various marine and oilfield uses capitalize on this property.

Research work has also been going forward on various types of reinforced nylon molding compounds. One manufacturer claims

to have developed a glass fiber-filled nylon with tensile strengths much greater than nylon in its virgin state. Another manufacturer reports on a molybdenum disulfide-filled nylon which offers high wear resistance, low dry running friction, and excellent dimensional stability.

Processing nylon

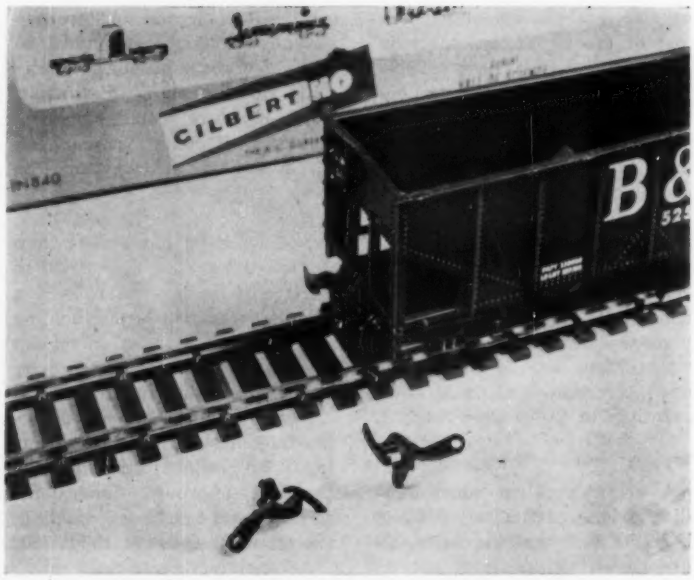
Injection molding and extrusion are the usual methods of processing nylon; application from solution, compression molding, sintering, and other techniques are used for special purposes.

The common nylon 6/6 and 6 compounds can all be handled in conventional machines with little modification in equipment or procedures. When injection molding nylon 6/6, what differences do exist can be attributed largely to the material's sharp melting point and low melt viscosity. This makes it necessary to fill molds as quickly as possible and the use of a booster is usually recommended. Nylon 6/6 also tends to freeze rapidly, contributing to rapid cycle and minimizing flash problems.

According to manufacturers of nylon 6, the material has a higher melt viscosity and a wider molten range than 6/6 nylon,[1] making it possible to mold parts having larger surface areas or thick cross-sections. Since the material does not solidify as quickly as other nylons, the sink marks and internal voids and cavities that might appear in heavier or thicker pieces are avoided. Manufacturers also claim that nylon 6 has a wider temperature working range (loosely defined as the temperature between which a resin becomes fluid and the temperature at which the resin undergoes temperature degradation) and that crystallinity which determines the degree of transparency or opacity can be more closely controlled.

In extrusion-grade materials, both nylon 6/6 (e.g., Zytel 42[2]) and nylon 6 are available with higher melt viscosities than were heretofore possible—and consequently extruded nylon profiles, tubing, pipe, film, and sheeting have started to find important new markets. Considerable activity has been noted in developing the use of nylon pipe in applications where the superior chemical resistance and heat resistance of the nylons is indicated. Extruded tubing has also made a place for itself in applications, e.g., pressure lubricating systems, where resistance to pressure and vibration combined with oil resistance are important. Extruded film and sheet is at present in the development stage but should shortly be made available for packaging and other fields.

Nylon, in stock shapes and sizes,



Miniature couplers, gears, pinions, and cams of nylon for toy railroad cars are precision molded and trimmed by fully automatic machinery. (Photo, Gries)

Molybdenumdisulfide-filled nylon was used for 11 parts of fuel pump because of better molding properties and higher wear resistance. (Photo, National Polymer)



[1] The extrusion-grade nylon 6/6s, however, are available with much higher melt viscosities than are available with the molding-grade nylon 6/6. See text, above.
[2] Trademark of E. I. du Pont de Nemours & Co., Inc.

can also easily be machined. This type of fabrication is especially recommended for symmetrical components with multiple undercuts, internal threads, and longer inside diameters. The break-even point between molding or machining nylon parts is generally higher for smaller parts. For example, results on a part with a volume of 0.7 cu. in. indicate it would be more economical to mold than screw machine in quantities of 2000 and up, while a part 0.1 cu. in. did not become more economical to mold until quantities of 40,000 were reached.

Drying

A major problem when handling nylons, particularly 6/6 and 6, is the fact that the materials are hygroscopic and will eventually absorb about 2½% moisture under average atmospheric conditions. However, more than about 0.3% moisture causes splayed moldings of reduced toughness. Therefore, every effort should be made to protect the molding powder from atmospheric moisture. If excess moisture has been picked up, the nylon should be dried in a circulating-air oven or a vacuum oven before the molding operation. It is most important that the air taken in by the drier be low in relative humidity.

Several after-treatments of nylon moldings are used to advantage. To relieve stresses, and thereby improve dimensional stability and toughness, moldings are often annealed at about 350° F. in an inert medium such as Glyco-wax S932. Furthermore, since 6/6 and 6 nylon, as mentioned above, will absorb about 2½% moisture under normal atmospheric conditions, it is often convenient to add about this much water by immersing in boiling water in order to improve the toughness of the molded piece.

Applications[3]

Nylon is more often used because of its combination of excellent properties than for any one single characteristic. These various properties have been exploited by a constantly expanding family of applications. The 6/6 and 6 nylons are particularly

[3] This section based on information supplied by L. T. Sherwood, Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc.

TABLE I: The nylons—raw materials, tradenames, properties

Chemical basis of nylon	*Common designation*	*Suppliers and tradenames*	*Comments on properties*
Hexamethylene-diamine-adipic acid	nylon-6/6	E. I. du Pont de Nemours and Co., Inc.—Zytel 42, 101, and 105	Zytel 42 is an extrusion-grade material with higher melt viscosity. Zytel 101 is a general-purpose material. Zytel 105 is same with carbon black added for weather resistance.
Hexamethylene-diamine-sebacic acid	nylon-6/10	E. I. du Pont de Nemours and Co., Inc.—Zytel 31 and 33	More moisture resistant than the above, more flexible, easier to work, less heat resistant, and less stiff. Zytel 33 is heat-stabilized Zytel 31.
Alkoxy-substituted nylon, hexamethylene-adipic acid		Belding-Corficelli Industries—B.C.I. Nylon	For fiber bonding and treating, extrusion, and solution-coating. By heat and/or acid can be cross-linked and made thermoset. Soluble when thermoplastic.
Not disclosed, possibly a copolymer		E. I. du Pont de Nemours and Co., Inc.—Zytel 63 and 69	Soluble in methanol and ethanol, but cannot be made insoluble. Used chiefly for textile treating.
Not disclosed, made specifically for the army		E. I. du Pont de Nemours and Co., Inc.—Zytel 3606	Made only to army specifications for infantry wire jacket.
Polycaprolactam	nylon-6	Barrett Div., Allied Chemical and Dye Corp.—Plaskon Nylon 8200 and 8201 E. I. du Pont de Nemours and Co., Inc.—Zytel 211 Spencer Chemical Co.—Spencer Nylon 401, 402, 600, 601, 602, 603, 604, and 606. Foster Grant Co., Inc.—Fostylon Alfred C. Toepfer, Inc.—Grilon American Enka Corp.—Nylenka	Controllable crystalline structure, permitting orientation for film. Fairly high molten viscosity. Wider plasticizing range for molding larger pieces.
Polymer based on castor oil derivative, 11-amino andecanoic acid	nylon-11	Rilsan Corp.—Rilsan	Easily plasticized. Low specific gravity. Fairly low melt point but high decomposition point. Very fluid. May be graphited for friction applications. High moisture resistance.

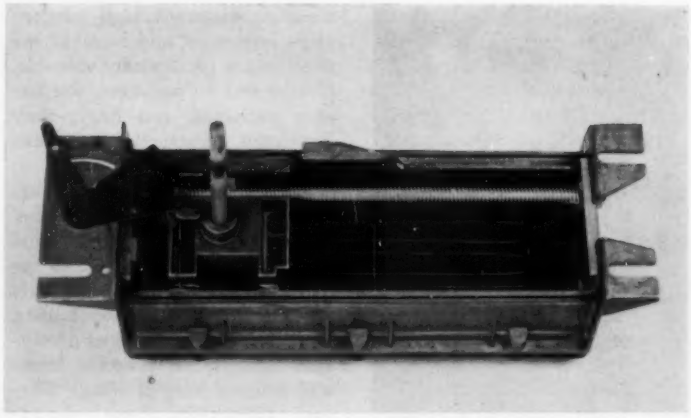
useful in molded mechanical parts. For example, nylon gears and bushings are being used in textile machinery, household appliances, calculating equipment, automobile speedometers, and windshield wipers, and in office and builder's hardware, to mention only a few. In addition to its other properties, nylon's excellent abrasion resistance in the absence of lubrication is particularly valuable where frequent oiling is either undesirable or inconvenient. For example, lubrication adequate for metal parts is often very undesirable in textile and food machinery, while in household appliances and fishing reels, it is apt to be neglected by the ultimate user.

Other mechanical parts using nylon's frictional properties include elevator gibs and sliding parts for storm windows.

Another of nylon's properties, its impact resistance, is particularly valuable for automobile and refrigerator door-closing mechanisms, many housings, cams, and aerosol bottles. Two recent developments are expected to promote this latter market even further. One is the availability of resins designed for extrusion and blow molding and the second is the development of spin-sealing techniques. This technique makes it possible to injection mold a bottle in two halves and economically join them together by a spinning operation.

The strength and stiffness of nylon are required in almost all of its uses. Its retention of these properties at elevated temperatures gives it wide acceptance for coil forms. These have been produced in tremendous quantities—offering economies due to mass production and injection molding techniques and because breakage during winding is minimized. In mixer valves for automatic washing machines its mechanical properties and inertness to hot water combine to make it the choice of a large majority of appliance manufacturers.

Nylon's electrical properties are adequate for many other electrical applications where its mechanical properties are of prime importance. These include switch housings, grommets, cable clamps and other fastening devices, insulated connectors, and numerous other molded parts in this category.



Tuner assembly for automatic washer has nylon drive plate which triggers timing device and nylon control rod which activates cycle sequence. (Photo, G.E. Co.)

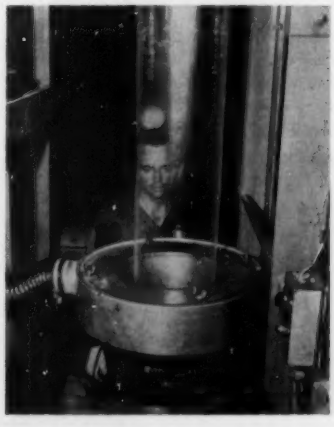
Nylon's chemical resistance is a determining factor in many applications. For example, marine equipment, aerosol valve parts, and moldings exposed to oil well brines must resist electrolytic corrosion. An outstanding new advance is the naval stuffing tube which is not only lighter and less expensive to produce than the conventional fittings, but also has excellent resistance to salt water corrosion.

Where long-term exposure to elevated temperatures (250° F.) is required, various heat-stabilized resins are available. Useful examples are electronic components and in fastening devices for the aircraft industry. Other resins for special purposes include the black weather-resistant nylons. These are suggested for use in agricultural machinery, sporting goods, electrical equipment, and for other applications where outdoor exposure is involved.

Extrusion applications for nylon are expected to account for an increasing share of the total business. Resins of viscosity suitable for molding may be used for simple extrusion operations where retention of shape is not critical. Here the low viscosity of many nylons above their melting points is not a handicap. However, where retention of shape after leaving an extruder die is important, as for blown bottles and any but the most simple shape extrusions, new high viscosity resins are now beginning to assume a more prominent place in the industry.

The use of nylon as a jacket for wire and cable is well established. In some cases, such as magnet wire and geophysical cable, it may be used as a primary insulant but it is more commonly used as a temperature- and abrasion-resistant jacketing over polyethylene, rubber, or vinyl compounds. Aircraft and other types of hookup wire, tree wire, and electric blanket wire are common examples. The softer grades of nylon are also used for control cable

Nylon-6 film, here being produced on standard equipment designed for polyethylene film, can be drawn down to 0.2 mil. (Photo, Spencer Chemical Co.)





Oil carrying can is assembled by heat-sealing two molded nylon-6 parts together. (Photo, Algemene Kunstzijde Unie, N.V.)

jackets, as in tiller cable for small boats and for various roll-up devices.

For outdoor applications, weather-resistant grades of extrusion resins have recently become available. These permit construction of highly abrasion-resistant wires with outdoor life comparable to the best materials.

The properties of nylon make it ideally suited for many tubing applications. Its strength, fatigue resistance, and chemical inertness, particularly to hydrocarbons, make it attractive for automotive and other lubrication systems, for fuel lines, air suspension systems, and many other applications. Its lightness and ease of assembly have made possible important economies in a great many installations.

Still other markets exist in films and laminates. Here the high abrasion resistance, high-temperature properties, and chemical resistance are particularly valuable. Grease and oil packages, sterilizable packages, and heavy-duty laminated constructions are examples.

A major potential market exists in the field of aerosol bottles. Here, strength, toughness, and impermeability contribute to the design of attractive bottles of almost unlimited color possibilities, with the added feature of protection against the possible losses and dangers from breakage. Several fabricators have already made production runs of nylon bottles and others are in the offing.

Less rigid and soluble types of nylon find many specialty uses. As moldings, they are useful where extremely high impact strength is required. Examples include soft-faced hammers and bowling pin bases. In the hammer application, prior to the selection of nylon, the manufacturer tested a wide range of materials by striking each one 140 times a minute with a sharp-pointed object giving a 50 ft.-lb. blow. Nylon lasted over 150 hr.—or approximately 1,260,000 blows—2½ times as long as the next best material. In addition, nylon offered several other advantages. It is dimensionally stable and the face of the hammer does not work loose from the ferrule in which it is seated. In addition, nylon does not mushroom or chip and gives an effective blow without bouncing or marring the work.

Applied as solutions or dispersions, the nylons form impermeable linings for aircraft fuel cells, and are widely used as soft, abrasion-resistant finishes for textiles, leather, and other products.

Injection molded nylon helmets take advantage of nylon's superior impact resistance and shock resistance. (Photo, J. Cerfontaine, Belgium)





Nylon gears and nylon assembly nuts for use in fishing reel line-measuring device are produced in a 10-cavity mold. (Photo, Du Pont)

References

Consult the Subject Index for additional information concerning nylon resins. For specific information on injection molding, see p. 650; extrusion, p. 702. See also the Adhesives, Coatings, Films, Laminates, and Plastics Properties Charts for information on properties. For sources of nylon resins, see Directory Index, p. 1018.

"New markets for nylon-6," by M. Stringfellow, MODERN PLASTICS *34*, 131 (Nov. 1956).

"Nylon drives heavy industry," MODERN PLASTICS *34*, 119 (Nov. 1956).

"Polyamide-11 in the electrical field," by R. Dumon, MODERN PLASTICS *33*, 151 (Aug. 1956).

"How much line is out?" MODERN PLASTICS *33*, 115 (Aug. 1956).

"Nylon bellows in explosion suppression device," MODERN PLASTICS *33*, 343 (June 1956).

"Effect of crystallinity on the properties of nylons," by H. W. Starkweather, Jr., G. E. Moore, J. E. Hansen, T. M. Roder, and R. E. Brooks, J. Polymer Sci. *21*, 189 (Aug. 1956).

"Some isomorphous copolyamides," by F. B. Cramer and R. B. Beaman, J. Polymer Sci. *21*, 237 (Aug. 1956).

"High-molecular-weight nylon. I. Comparison with other polyamide materials," by W. Stiner, Plastics (London) *21*, 141 (June). II. "Processing techniques," ibid. 174 (July). III. "Properties as a packaging material," ibid. 207 (Aug. 1956).

"Polymer characterization: a typical copolyamide system," by R. G. Beaman and F. B. Cramer, J. Polymer Sci. *21*, 223 (Aug. 1956).

"Large-diameter nylon pipe for export," Rubber and Plastics Age *37*, 376 (June 1956).

"Better 'nylon' in the making?" Chem. Week *78*, 54 (Mar. 31, 1956).

Phenolics

BY A. P. LANDALL*

The history of phenolics dates back about fifty years to the time when Dr. L. H. Baekeland first announced the controlled phenol-formaldehyde resin reaction in 1909. The significance of Dr. Baekeland's work was the ability to control the phenol aldehyde reaction and his visualization of its commercial possibilities. Coincidental work in the field was carried out by Aylsworth and by Redman and his co-workers, Weith and Brock.

PHENOL-FORMALDEHYDE

The advantages the phenolics offer are many. With proper manufacture and application, phenolic is a strong, rigid, dimensionally stable material, resistant to heat and a wide variety of solvents, and, most important, a nonconductor of electricity. It is this last characteristic that has given the greatest impetus to the large-volume usage of phenolic materials.

Chemistry

Phenol and formaldehyde combine in the presence of a catalytic agent to produce phenolic resins. These phenolic resins can be classified broadly as either one-stage or two-stage resins.

When a mol ratio of 1:1 or greater of formaldehyde to phenol is used in combination with an alkaline catalyst such as caustic soda or ammonia, the reaction yields a *one-stage* resin which is called a resol in its initial stage. There are only four general types of reactions that are universally accepted as taking place under alkaline catalysis during resinification. These four reactions are capable of many combinations and permutations, which makes the study of this resin's technology extremely complex. The four basic reactions include: 1) methylolation; 2) condensation of two methylol groups to form an ether bridge; 3) condensation between a methylol group and a phenol nucleus to form a methylene bridge; and 4) decomposition of ether bridges to form methylene bridges and formaldehyde which immediately reacts via the first three reactions. These reactions are capable of taking place in any open ortho or para position in any phenolic nucleus no matter how large the methylolation. They can also result from the formation of a methylene bridge by condensation between a methylol group and a phenol nucleus in any open ortho or para position, no matter how large the polymer molecule may be.

Any methylol group present in the polymer may undergo a condensation of two methylol groups to form an ether bridge or condensation to form a methylene bridge. Any ether bridge in any phenolic polymer may be decomposed to form methylene bridges and formaldehyde and, of course, undergo further reaction.

The general procedures used are as follows:

In the manufacture of a one-stage resin all of the monomers needed for full polymerization are charged to the resin kettle at the start. The initial increase in viscosity because of the

*Supervisor, Technical Service, Chemical Materials Dept., General Electric Co., 1 Plastics Ave., Pittsfield, Mass.

Recent Developments and References were prepared by the editors.

RECENT DEVELOPMENTS

A new phenolic molding compound (*Resinox 2200 Black*, Monsanto Chemical Co.) combines excellent dimensional stability with high arc resistance and good impact strength. Formulated for use in heavy-duty electrical control parts and wiring devices, it is also well-suited for the manufacture of other parts requiring superior dimensional stability during temperature cycling, improved impact strength, and resistance to surface arcing.

A mineral-filled phenolic molding compound in nodular form (*RX-460*, Rogers Corp.) is intended for applications requiring greater strength than is usually found in heat-resistant materials suitable for automatic molding and preforming.

An ammonia-free, wood-flour-filled phenolic compound (*Durez 18441*, Durez Plastics Div., Hooker Electrochemical Co.) has been developed for use where a single-stage electrical-grade material of general-purpose type is required to minimize corrosion of electrical contacts and metal inserts. The compound has a very fast rate of cure, good finish characteristics, and low gravity. It is especially suitable for automatic compression, plunger, and transfer molding processes.

A medium-high impact molding compound (*RX-470*, Rogers Corp.) with cellulose filler is the highest impact material available in nodular form. It is preformable on automatic preforming equipment which is equipped with vibrating-feed hoppers and filling tubes of adequate cross-section area. According to the manufacturer, it has a fast rate of cure and molds with an excellent finish for a material of this impact class. The impact strength (ft.-lb./in. of notch) for a molded specimen is 1.50 (min.).

A new one-stage phenolic (*12902*, General Electric Co.) is designed specifically for molding in automatic presses. It offers fast cure rates, excellent release characteristics, low bulk factor, and uniform granulation. This manufac-

turer also announced two new improved general-purpose compounds (*12920 Black* and *12921 Brown*) with wider flow range, improved finish, longer flow duration, and faster cure and a new high-heat resistant phenolic molding powder (*G-E 12980*).

A heat-resistant, medium-impact phenolic (*HR-322*, Durite Dept., The Borden Co., Chemical Div.), which can be compression and plunger molded and preformed, is used in utensil handles, automatic skillet thermostat housings, and similar applications. It has withstood up to 450° F. for 24 hours.

Paper can be made fireproof by impregnating it with a new resin (*Synco 85*, Synco Resins, Inc.). The paper also shows the increased strength and chemical resistance characteristics of phenolic-impregnated materials. Paper so impregnated is expected to find application in air filters, insulation, honeycomb cores, overlays, and laminates.

An epoxy-based enamel (*Rexclad "R'*, Rexton Finishes, Inc.), available in almost any color including metallic, can be applied to phenolics at a cost of approximately 1¢/sq. foot. It is used on radio cabinets, steam iron handles, base plates for coffee makers, control switches on electric blankets, etc.

A new phenolic coating (*Phenoline 305*, Carboline Co.) produces a 12-mil protective phenolic surface with only two coats. It is a modified phenolic with 86% solids content, applies at 6 mils per coat, and is catalytically set. The coating is recommended for use on equipment, exteriors, ceilings, and concrete floors in corrosive environment.

condensing of methylol groups is the *A-stage* or *resol stage*. The resol is readily soluble in alkalies, and in solvents such as acetone. Resols are low-melting and of low molecular weight. The product at this stage is mostly phenol alcohol. As polymerization continues, the resins enter the *B-stage*. The B-stage resins, sometimes called *resitols*, are still fusible but are soluble only with difficulty. The *C-stage* or *resite* is considered to be the final cure of the resin and is represented by the curing in a mold of a molded part.

If a mol ratio of less than 1:1 of formaldehyde to phenol is used in combination with an acidic catalyst and reacted under proper conditions, the resultant resin is a *novolak* and is considered noncuring. Generally speaking, chemists recognize only one type of reaction between phenol and formaldehyde under acid catalysis. This reaction consists of a condensation of 1 molecule of formaldehyde with 2 phenol nuclei to form a methylene bridge with the elimination of water. This reaction takes place in either the ortho or para positions. As mentioned before, the end product of this reaction is a novolak which is permanently fusible and for practical purposes noncuring. In order to make this resin infusible and capable of being cured, a source of additional methylene bridges must be reacted with it. This is done through the addition of hexamethylenetetramine, commonly known as hexa. It is accepted by most authorities that the ammonia present in the hexa acts as the catalyst in furthering the cure of the so-called *two-stage* resins.

Available forms

Phenolic resins may exist in either solid or liquid form; sometimes alcohol solutions are used as varnishes.

Resins for phenolic molding compounds are generally available as powdery, finely-ground solids and are usually mixed with fillers, lubricants, dyes, pigments, etc., and further processed.

Liquid phenolic resins or varnishes are used extensively by the laminating industry in the manufacture of industrial and decorative laminates. Liquid resins are also used in the formulation of protective coatings and adhesives, and in numerous applications as an impregnant or as a bonding agent for wood, paper, etc. Casting resins are another prime outlet for liquid phenolic.

The foundry industry, in manufacturing shell molds, usually employs a solid resin, although recent activity has indicated some preference for a liquid resin.

Foamed materials are one of the newer forms of phenolic that has attracted considerable attention for insulation applications and sandwich constructions. Microscopic phenolic spheres are also used as a surface layer on the top of tank-stored petroleum products to prevent evaporation of the liquid, and as an ingredient of a new type of syntactic foam.

Molding compounds

Phenolic molding materials, sometimes called compounds, are produced in granular, nodular, or macerated forms. Fillers used in molding compounds consist of wood flour, cotton flock, macerated rag, varying lengths and types of asbestos fiber, mica, sisal, glass, and many other organic and inorganic materials. The most common form of molding compound, the granular type, is made by premixing the proper quantities of resin, filler, lubricants, and colorants, and processing this premix on heated differential rolls. This partially advances the resin and densifies the product. The material is stripped from the rolls in the form of a dense, brittle sheet which is then ground to the proper particle size.

A knowledge of the general effect of specific filler types is essential for the engineer so that he may properly design for existing end-use application. The molding compound supplier has done this for him by setting up such broad general compound classifications as general-purpose, impact-resistant, heat-resistant, shock-resistant, etc. Fully cured molded phenolic articles are durable, inert, dimensionally stable, and resistant to burning. They are inert to most common solvents

and weak acids. They are attacked rather rapidly by strong caustic solution. Generally speaking, phenolics are available only in dark colors since they tend to darken on aging or exposure to sunlight. Epoxy spray or dip coats can be used to color molded phenolic parts.

Phenolic molding compounds generally are molded at 3500 p.s.i. and curing temperatures are usually between 300 and 370° F. Phenolics can be molded by either compression or transfer methods and in almost any shape or size.

Laminating resins

One of the most important uses of phenolic resin varnishes is in the manufacture of industrial laminates as well as in decorative laminates such as those used for tabletops and countertops. The laminates are second only to the molding materials in consumption of phenolic resins and account for over 15% of all phenolic resins.

Special formulations of resins and varnishes can be used to manufacture many varieties of laminated products with varying characteristics. The laminating process consists essentially of running a paper or fabric through a solution of the phenolic resin or varnish and removing volatile materials in predetermined quantities. This is done by passing the treated paper or fabric through a circulating hot air oven at a predetermined rate. The dried and partially cured paper or fabric is then cut to proper size, a number of plies are placed one on top of the other, and the combination is loaded into a hydraulic press where pressure is applied. Polished plates in the press give a smooth surface to the finished laminate. Heat applied to the laminate while it is in the press gives it the final cure.

Coatings and adhesives

Approximately 6% of total phenolic resin usage is in protective coatings. Even though the poundage still sounds attractive, the growth picture in recent months has been relatively poor due to the advent of some of the newer synthetics such as the modified alkyds.

Phenolics as protective coatings, however, have been in use for a good many years and therefore are worthy of mention. The two types used are straight phenol-formaldehyde resins and resins that have been modified with an ester gum to impart hardness and gloss to the finished product.

Phenolic resins used for adhesives generally are characterized as hot-setting adhesives. They require heat and usually pressure to effect a satisfactory cured bond. Generally speaking, the resins used in the manufacture of adhesives are of the same general type as those used in the laminating industry. With the correct selection of phenolic resins, bonds can be effected that are as strong as the base material itself and in some cases considerably stronger.

For reasons of economy phenolic liquid resin adhesives can be partially extended with inert fillers, such as walnut shell flour, without greatly affecting the bond strength. Temperature ranges usually employed run between 250 and 350° F. and pressures up to 300 p.s.i. are used for bonding.

The plywood industry uses almost 10% of all the phenolic resins manufactured. This is the largest single application for adhesives.

Phenolic resins are also used extensively in the bonding of waste wood and particle wood in the manufacture of structural board for many purposes.



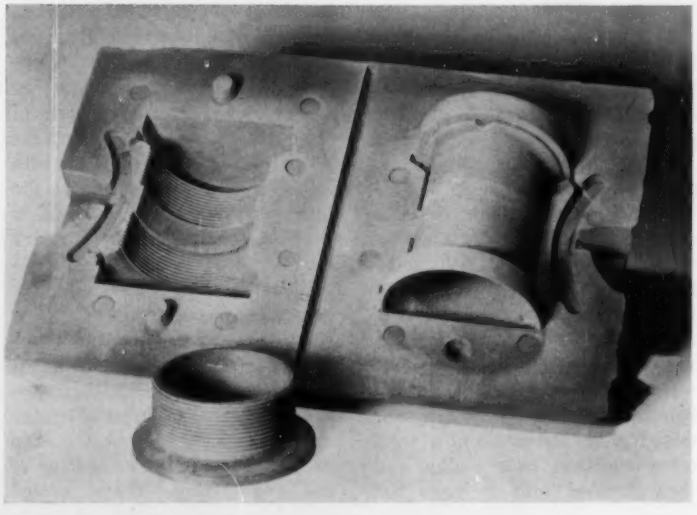
Phenolic-rubber compound is used for molding brake motor collector ring. Brass rings are molded in. (Photo, G.E.)

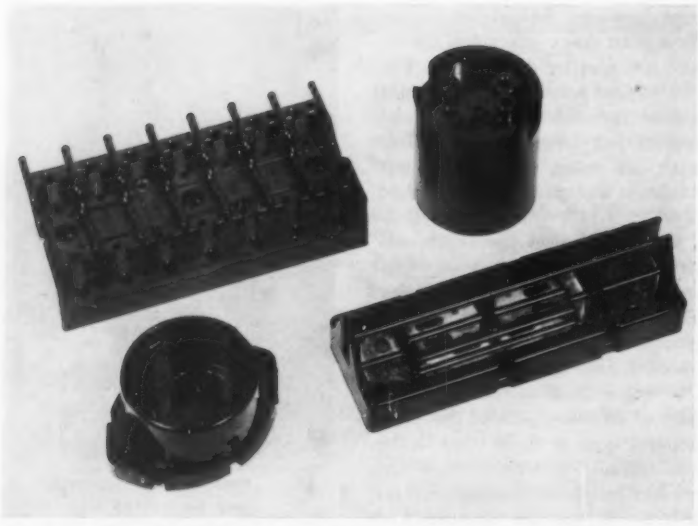
Casting phenolics

Cast phenolics are widely recognized in certain decorative applications such as special cast shapes for cabinets, buttons, and poker chips.

Though not as well-known to the general public, industrial castings are of far greater importance. Cast phenolics are the cheapest of the casting resins in

Sand shell foundry molds bonded with phenolic resin allow metal casting to close tolerances, save thousands of dollars annually in machining costs. (Photo, G.E.)





Intricate accessory switch components are automatically molded of new one-stage phenolic molding compound especially formulated for fast cure. (Photo, G.E.)

wide use today. Liquid phenolic resin types are used in casting with a solid content of 50 to 90%, depending on formulation and the degree of advancement. Molds for casting phenolic resins can be made quickly and cheaply from a wide variety of materials. They are most commonly made from plaster of paris and lead. Cast phenolics must be cured slowly to avoid bubbles, crazing, and excessive shrinking. Hardness, rigidity, excellent dimensional stability, good strength, and resistance to both abrasion and impact are the characteristics that have led to their wide acceptance.

Bonding agents

The use of phenolic resins in thermal insulation and in the manufacture of brake bands accounts for almost 15% of total phenolic resin usage.

In the application of phenolic resin as a binder in glass wool insulation, the phenolic resin is sprayed onto the glass fibers as they drop down through the spinning tower. The coated fibers are then deposited on a moving belt, compressed to the desired thickness, and oven-cured.

In the manufacture of brake bands, powdered phenolic resin is mixed with asbestos fiber and other additives in a muller and then pressed into a large flat sheet. Before curing is completed, these sheets are rapidly cooled and the brake band segments are die-cut to the proper shape. These segments are then formed over a suitable forming fixture with heat and pressure and the final cure is achieved.

Foundry industry

Although the foundry industry accounts for only slightly more than 2% of the total phenolic resin usage, this application has the brightest growth picture of all. Within the last few years phenolic resins have been used in an increasingly larger quantity in the foundry industry because of the economic advantage gained through their adaptability to smoother castings, closer tolerances, and less machining.

The basic process consists of mixing relatively low percentages (4 to 8%) of phenolic resin with foundry sand. Depending on the process used, this might be either a dry mix or a wet mix. The dry mix has the disadvantage of segregation of resin and sand but possesses the advantage of low capital investment for the foundrymen. The wet process or the coated sands requires higher capital investment in terms of equipment necessary to coat the sand properly. It has the advantage of not segregating. These coated sands are blown onto a hot pattern; the layer of material which adheres to the pattern is cured by the heat. The process of using the coated sands enables the foundry to reduce resin content considerably. Even though the individual application uses little resin, the economic picture is attractive. It is expected that many more foundries will utilize the process and thereby increase considerably the total poundage of phenolic resins for foundry industry use.

PHENOL-FURFURAL

Even though formaldehyde is the most commonly accepted aldehyde used in reaction with phenol, furfural is used to some extent because of the modifying characteristics that it can give to a phenolic resin. Phenol-furfural resins have been made for a good many years, the basic patents having been issued between 1921 and 1929. Development of techniques for large-scale production of furfural from waste oat hulls helped stimulate activity in this field.

The chemical nature of furfural is responsible for its ability to condense with itself to form a polymer. Not only does the aldehyde group enter into this reaction but so also does the furan ring, providing a cross-linked molecular chain. Furfural resins possess excellent chemical resistance and are capable of high strength.

Phenol-furfural resins are used primarily as modifiers with standard phenolic resins to impart special characteristics to the molding compound. Furfural resins are characterized by extreme duration of flow at lower temperatures and very rapid cure rates at higher temperatures. By judiciously balancing the amount of furfural resin included in a standard phenolic formulation, molding compositions can be manufactured with exceedingly long duration of flow characteristics. This is exemplified by the earlier work on large television cabinet moldings. The early success of these phenolic television cabinets was due in large measure

to the incorporation of furfural resins to give the long duration of flow necessary.

By curing at elevated temperatures (375 to 400° F.) cures can be obtained that are faster than those obtained with the straight phenol - formaldehyde resins.

As modifiers, approximately 1 million lb. of phenol-furfural resins are manufactured per year.

RESORCINOL-FORMALDEHYDE

Resorcinol aldehyde reactions are very similar to phenol aldehyde reactions except that the resorcinol is much more reactive than phenol. This is, of course, due to the fact that there are two activating OH groups as opposed to the one activating group in phenol. Resorcinol has the highest rate of reaction with an aldehyde of any common phenolic body. This high rate of reactivity has made resorcinol resins extremely difficult to control and has somewhat limited their usage. Control can be attained, however, by reacting with a deficiency of aldehyde. This results in a very stable resin which can be stored for long periods of time, as long as the material remains deficient in aldehyde content.

Cures are attained by adding a source of more aldehyde, usually paraform, to obtain room temperature cures. These cures are essentially neutral and therefore the resorcinol aldehyde resin does not degrade fibers or other structures. This characteristic is extremely important in gluing or bonding. Because of the exceedingly high rate of reactivity, resorcinol resins are capable of exceedingly fast cures. The idea of a molding compound with exceedingly fast cures has intrigued the material supplier for many years. Available literature advises that the addition of small quantities of resorcinol resin can speed the cure of phenolic molding materials. However, due to the extreme critical nature of controlling this reaction, no composition has been manufactured which would either consistently produce low cures or could be manufactured with reasonable facility.

The outstanding usage of resorcinol resins is as adhesives. These glues have outstanding characteristics. The bond is fungusproof and is not affected by moisture or boiling water. These characteristics make it ideally suited for bonding plywood, and the plywood industry uses most of the resorcinol resins made. The process, known as assembly gluing, takes advantage of resorcinol adhesives in the manufacture of arches and structural members made from wood. It is also used to a large extent in boat construction.

Since resorcinol resins are expensive, it is common practice to blend phenolics with them in proportions that will still allow room temperature cures to be attained. Further economies can be achieved by extending still further with phenolic resins and gluing by means of a hot-pressing technique. These resin adhesives are extensively used in wood cabinet making. These adhesives are characterized by their high affinity for wood and they are the only low-temperature setting adhesives which also have maximum resistance to exposure.

References

Consult the Subject Index for additional information concerning phenolic resins. For specific information on compression and transfer molding, see p. 680; laminating, see p. 506; casting, see p. 741. See also the Adhesives, Coatings, Foamed Plastics, Laminates, Low-Pressure Laminating Resins, and Plastics Properties Charts for information on properties and trade designations. For sources of phenolics, see Directory Index, p. 1018.

"World's largest pressure moldings," MODERN PLASTICS *33*, 106 (Aug. 1956).

"Advances in thermoset molding," by E. F. Borro, MODERN PLASTICS *33*, 145 (May 1956).

"Phenolic resin process design," by F. W. Hammesfahr, D. C. Johnson, S. N. Johnson, and S. Seltzer, MODERN PLASTICS *33*, 139 (Feb. 1956).

"Determination of methylol groups in phenolic resins," by G. A. Steinmark and F. T. Weiss, Analytical Chem. *28*, 260 (Feb. 1956).

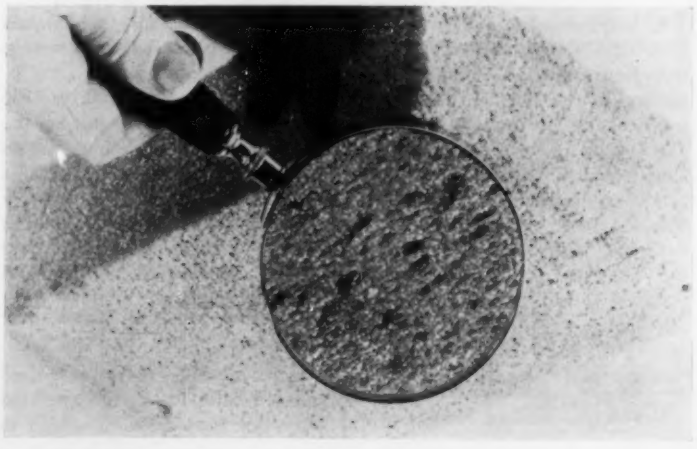
"Cross-linking of a phenol-formaldehyde novolac," by M. F. Drumm, C. W. H. Dodge, and L. E. Nielsen, Ind. Eng. Chem. *48*, 76 (Jan. 1956).

"Degree of cure in thermosetting resins," by E. Barr, Ind. Eng. Chem. *48*, 71 (Jan. 1956).

"Internal pressure distribution in molding phenolic test bars," by J. M. Rausch and W. Orvis, SPE J. *12*, 24 (Jan. 1956).

"Phenolic resins," Canadian Plastics *1955*, 40 (Oct.).

Cellular structure of phenolic foam (under magnifying glass) makes the material especially useful for many types of insulation applications and as a core material in sandwich constructions. (Photo, G.E.)



Polyester (Alkyd) Resins

BY W. O. ERICKSON* and V. W. GINSLER*

The esterification reaction between polyhydric alcohols and polybasic acids produces a large class of materials known as polyester or alkyd resins. These resins exhibit a wide range of properties and are utilized in highly diversified commercial applications. The wide range of properties results largely from the type and proportions of chemical components used in manufacture.

When a saturated dihydric alcohol (i.e., one containing no double bonds) is reacted with a saturated dibasic acid under controlled conditions, water is evolved and chain molecules having terminal hydroxyl or carboxyl groups result. These molecules are the saturated polyesters. They can undergo further intermolecular condensations but cannot be cross-linked.

When a dihydric alcohol and a dibasic acid, either or both of which contain a doubly-bonded pair of carbon atoms, are reacted, an unsaturated polyester is obtained. The double bonds render the unsaturated polyester capable of subsequent cross-linking. The unsaturated polyesters usually are blended with a reactive monomer (such as styrene) and reacted under the influence of special catalyst systems. The polyester and the monomer copolymerize to form a thermoset.

There is considerable confusion in references to the type of polyesters involved in various applications. By chemical definition, the reaction product derived from a polyhydric alcohol and a polybasic acid, whether or not the reaction product is modified by special alcohol or acid components, is still properly called a polyester. For practical purposes, however, an oil-modified polyester (i.e., a fatty acid-modified polyester) always is referred to as an alkyd or alkyd coating resin. To add to the complication, because the alkyd rather than the polyester designation was chosen to refer to certain proprietary molding compounds introduced some years ago, the practical usage of alkyd molding compounds now has been established. Certain saturated polyesters have become useful plasticizers and often are referred to as polymeric plasticizers. Other special polyesters are formed into film and textile products. A polyester product is a principal ingredient of polyurethane foams.

POLYMERIZABLE (UNSATURATED) POLYESTERS

The polymerizable polyesters are a relatively new class of resins that first appeared commercially during World War II. They are noted especially for ease of handling, good physical and electrical properties, and speed of cure. Initial applications were in combination with fibrous glass in radomes, body armor, and various nonstructural aircraft parts.

After World War II, gradually lower resin costs, better technical know-how, and improved production techniques helped result in an increasing number of applications.

Polyester resin volume in 1956 was approximately 64 million lb., about a 33% increase over the 48 million lb. sold in 1955. This class of resins now is used for matched-metal molding, premix materials, laminates and hand lay-up applications, casting, and encapsulation.

Chemistry

A polyester, as the term is used here, refers to an unsaturated polyester base resin dissolved in a polymerizable monomer. The base resin component can be prepared from innumerable chemical combinations. It is this base component that usually is modified to obtain the various properties of the finished polyester.

Essentially, dibasic acids and dihydric alcohols are heated to sufficiently high temperatures to react, split out water, and form ester linkages. As the reaction proceeds, many ester linkages are formed in one linear molecule. It is essential that at least a certain portion of the dibasic acids or the dihydric alcohols be unsaturated, i.e., contain double bonds, to provide for the function of copolymerization. It is through the connecting of these double bonds with those of the monomer that curing takes place.

The dihydric alcohols most commonly used are glycols of ethylene, propylene, 1,3- and 2,3-butylene, diethylene, and dipropylene. Unsaturated dihydric alcohols are not commercially available. The dibasic acids, therefore, must supply the necessary unsaturation or double bonds to the polyester base resin. The unsaturated dibasic acid is usually maleic anhydride or fumaric acid. The most common saturated dibasic-acid components are phthalic anhydric, and adipic and azelaic acids.

The polymerizable monomer can be styrene, vinyl-toluene, diallyl phthalate, methyl methacrylate, or triallyl cyanurate.

Under the influence of heat and/or peroxide catalyst, the monomer and unsaturated polyester base copolymerize. No gas or liquid is evolved during the cure. The curing reaction is exothermic and the heat evolved aids in speeding the cure. The particular nature of this polymerization provides the vital factors of speed and simplicity so important in field applications of polyesters.

Fabricating methods

The main fields of application for the polymerizable polyesters are hand lay-up, preform, mat and premix molding, and casting.

The hand lay-up method is used to make large shaped articles such as boats and radomes. Fibrous glass mat or cloth sup-

*Glendale-Plaskon Laboratory, Barrett Div., Allied Chemical & Dye Corp., P. O. Box 27, Station 1, Toledo, Ohio.

Recent Developments and References were prepared by the editors.

A polycarbonate resin (*Lexan*, General Electric Co.) offers an unusual combination of toughness, heat resistance, impact strength, and dimensional stability. The manufacturer expects this thermoplastic material to replace cast metals, ceramics, and other plastics in some applications. It is suggested for applications such as coil forms, appliance parts, gears, housings, structural parts, electronic components, and telephone accessories.

Prescription lenses of an allyl base copolymer (*Enduron Prescription Lenses*, Pioneer Scientific Corp.) are manufactured in a full foci range, including bifocals and cataract lenses, and comply fully with the latest standard opthalmic and Federal specifications. Although this material does not have the abrasion resistance of glass, it is 30 to 60 times more abrasion-resistant than most other optical plastics.

Polyester resin especially formulated for rapid casting or embedding is available in low-cost educational-experimental kits for the student, inventor, model maker, or product design engineer (*Chemiglas*, Technicraft Co.).

A fire-resistant light-stabilized resin (*Hetron 93LS*, Durez Plastics Div., Hooker Electrochemical Co.) is used to make glass fiber-reinforced corrugated sheet which has been fire-tested and approved for unlimited use as industrial glazing. Two additional polyester resins were announced by this company. One (*Hetron 72*) combines good chemical resistance, fire resistance, and excellent heat resistance; the other (*Hetron 32A-LS*) is a semirigid resin with outstanding physical properties, fire resistance, and weather stability which meets the requirements of MIL R 7575A and is of special interest for large radome structures. A transparent lacquer (*Hetrolac 105*), when applied in very thin coatings, extends the life of glass-polyester compositions exposed to weathering.

A silica-filled polyester resin composition (*Haveg 7010*, Haveg Industries, Inc.) was developed for use with brick and tile tank linings and for laying floors and walls in chemical processing areas. This polyester cement is said to resist a wide range of chemicals, including both acids and mild alkalies at high temperatures, concentrated alkalies at room temperature, and oxidizing agents. Service temperatures up to 265° F. are recommended.

A complete line of polyester resins (*Amester*, American Alkyd Industries) includes a general-purpose resin (*Amester 722*), a light-stabilized resin (*722 L.S.*), a reactive resin (*502*), matched-metal die resins (*552*), a low viscosity resin (*722 L.V.*), a thixotropic resin (*822*), a fire-retardant resin (*852*), a flexible resin (*922*), and a gel coat (*1022*).

A general-purpose molding resin (*MR-42R*, Celanese Corp. of America) has good resistance to crazing or cracking in resin-rich areas of the molding. Molding cycle, mold release, lack of mold scumming, degree of fiber wetting, hot strength of molded part, surface gloss, and resistance to warping are equal or superior to similar resins. This resin is also promising in the premix molding field.

A new thixotropic agent (*Thixcin E*, Baker Castor Oil Co.) effectively inhibits crawling, sagging, draining, and pigment setting in polyester resins. The additive is characterized by easy stir-in, with maximum results attained at temperatures of 90 to 110° F. As little as 0.2% imparts a highly thixotropic body.

Transparent conductive coatings (*Sierracote*, The Sierracin Corp.) which are essentially metallic in nature may be deposited by special high-vacuum techniques on glass or other chemically stable glazing materials such as a cross-linked polyester plastic (MIL-P-8257A).

A modified polyester-type adhesive (*46971* Adhesive, E. I. du Pont de Nemours & Co., Inc.) for polyester film (*Mylar*) was developed to overcome rapid evaporation of methylene chloride and consequent difficulty in roller coating or gravure printing. The solvent used in the new product is 1,1,2-trichloroethane. This company supplies three classes of adhesives for Mylar: 1) modified synthetic rubber type, 2) vinyl type, and 3) polyester type.

---

plies the necessary reinforcement. Either a male or female mold can be used. The polyester-fibrous glass laminates are laid up against the mold. Sometimes a bag of impervious material is placed over the laminate, and either vacuum or pressure used to hold it in place during cure. Curing can be at room or elevated temperature. Production is slow.

Preform or mat molding utilizes heated, matched-metal molds. The mat or preform is placed into the heated mold, the catalyzed polyester is poured in, and closing the mold forces the resin throughout the reinforcement. Conventional molding cycles are 2 to 4 min. at 220 to 260° F. and 50 to 200 p.s.i.

Premix molding provides a rapid method of making less critical parts at considerably lower cost than mat or preform molding. It makes possible the molding of parts with varying wall thicknesses, intricate contours, and molded-in inserts. In this method, resin, reinforcement, filler, and catalyst are mixed in a dough-type mixer. The resulting material varies from a putty- to straw-like mass depending on composition. Typical molding cycles are ¾ to 2 min. at tempera-

TABLE I: Typical properties of cast, unfilled, rigid polyester

(Determined on laminates 1/8 in. thick)

Barcol hardness	48
Specific gravity	1.22
Ultimate tensile strength, p.s.i.	10,600
Ultimate compressive strength, p.s.i.	22,500
Ultimate flexural strength, p.s.i.	16,700
Modulus of elasticity in flexure, p.s.i.	6.9×10^5
Heat distortion temperature, ° C.	90
Water absorption, 24 hr., %	0.21
Flammability, in./min.	0.87
Dielectric constant at 60 cycles	3.43
at 10^6 cycles	3.00
Power factor at 60 cycles	0.012
at 10^6 cycles	0.015
Dielectric strength	
Short-time test at 25° C.	344
at 100° C.	312
Step-by-step test at 25° C.	308
at 100° C.	259

TABLE II: Properties of typical rigid polyester laminates

(Determined on castings 1/8 in. thick)

	Mat laminate[1]	*Cloth laminate*[2]
Resin content, %	63.9	38.0
Specific gravity	1.49	1.80
Barcol hardness	51	69
Ultimate tensile strength, p.s.i.	16,900	45,000
Ultimate compressive strength, p.s.i	27,000	35,400
Water absorption, 24 hr., %	0.18	0.13
Ultimate flexural strength		
at 73.5° F., p.s.i.	37,500	58,700
at 160° F., p.s.i.	23,800	51,700
after 2-hr. boil, p.s.i	21,600	53,100
Modulus of elasticity		
at 73.5° F., p.s.i.	1.45×10^6	3.0×10^6
at 160° F., p.s.i.	0.78×10^6	2.3×10^6
after 2-hr. boil, p.s.i	1.11×10^6	2.7×10^6

[1] Mat laminate: 3 plies of 2-oz., chrome-finished glass mat, cured 3 min. at 235° F. between metal platens at a pressure of 0 to 15 p.s.i.
[2] Cloth laminate: 12 plies of 181-style glass fabric, silicone-finished and cured 3 min. at 235° F. between cauls at a pressure of 0 to 15 p.s.i.

tures of from 270 to 300° F. and at pressures of from 500 to 1500 p.s.i.

In the casting field, little if any reinforcing agent is used. Castings are made from both clear and filled resin by pouring the catalyzed resin into a mold. Curing can take place at room or elevated temperature.

Properties and uses

The important general properties typical of all polymerizable polyesters are: 1) Ease of handling. Polyesters in the uncured state are easily handled liquids. They cure to a solid material with no liquid or gases evolved. 2) Rapid cure for thermosetting resins. 3) Ease of coloring. Polyesters are light-colored liquids which can readily be pigmented to any desired color. 4) Excellent dimensional stability. 5) Good electrical properties. 6) Good physical properties.

Specialty type polyesters designed for specific applications can have one or a combination of additional properties:

1) Good weathering resistance and light stability; 2) heat resistance—the use of monomers, such as triallyl cyanurate, in conjunction with highly unsaturated polyester bases, raises the operating temperature of polyester-fibrous glass laminates to 500° F.; 3) flame resistance; and 4) corrosion resistance.

Polyester resins are so widely used that only a listing of the major fields can be given here.

Building panels are a major

TABLE III: Typical physical properties of unfilled, cast blends of rigid and flexible polyester resins

Resin content		*Heat distortion temperature (264 p.s.i.)*	*Tensile strength*	*Elongation*	*Flexural strength*	*Modulus of elasticity in flexure*
Rigid	*Flexible*					
%	%	° C.	10^4 p.s.i.	%	10^3 p.s.i.	10^5 p.s.i.
100	0	90	10.6	1.8	16.7	6.9
90	10	84	11.2	2.3	17.3	6.8
80	20	79	10.1	2.8	17.5	5.6
70	30	73	9.1	3.7	18.3	5.4
60	40	66	8.5	4.8	15.1	3.9
50	50	59	5.8	8.2	11.2	2.7
40	60	52	4.2	22.1	—	—
30	70	47	3.3	32.2	—	—
20	80	38	2.7	41.2	—	—
10	90	—	2.3	54.2	—	—
0	100	—	1.4	65.3	—	—

utlet for polyesters and are designed to take advantage of the material's ease of handling, good weathering resistance, ease of coloring, and good physical properties. These sheets are made in light transmissions varying from 5 to 80 percent. They are used principally as skylights, industrial glazing, and awnings.

Premix materials constitute one of the fastest growing segments of the polyester field at present. Major end uses are electrical equipment parts, refrigerator striker plates, automotive heater ducts, automotive air conditioner parts, and automotive garnish moldings (window frames).

Matched-metal moldings are represented by cafeteria trays, tote boxes, chairs, laundry tubs, washing machine tubs, automotive parts, luggage, and boats.

Hand lay-up applications, which were the first large-scale applications of polyester resins, are still major production items. Radomes up to 36 ft. in length are being produced, boats up to 24 ft. long are in volume production, and tanks of various types are being made for the storage of certain corrosive liquids, for electroplating baths, and for similar uses.

Castings are being produced for aircraft glazing. Filled castings are being used in electrical components. Decorative castings are the most rapidly growing segment of this field. Polyester buttons are produced in quantity.

TABLE IV: Effect of oil content on properties of alkyd resins[1]

Property	Percent oil modification: 30 (aromatic)	40 (aromatic)	50	60 (aliphatic)	70 (aliphatic)
Solubility	→	→	→	→	→
Viscosity	←	←	←	←	←
Curing time	←	←	←	→	→
Hardness	←	←	←	←	←
Brushing ease				→	→
Flow	→	→	→	→	→
Sagging	→	→	→	→	→
Grinding ease	→	→	→	→	→
Initial gloss	←	←	←	←	←
Gloss retention	←	←	←	←	←
Color retention	←	←	←	←	←
Exterior durability	→	→	→	←	←
Water impermeability	→	→	→	←	←
Can stability	→	→	→	→	→

[1] Adapted from "Theories and facts concerning alkyds," by K. A. Earhart, Ind. Eng. Chem. *41*, 716-725 (1949).

Commercial polyesters

Polyesters available commercially may be designated as general-purpose, resilient, flexible, flame-resistant, light-stabilized, heat-resistant, and corrosion-resistant. In general, the resins commercially available range in stiffness from rigid to flexible when cured. Typical properties are given in Tables I, II, and III (p. 142).

ALKYD COATING RESINS

Polyester resins used in organic coatings are usually known as alkyds. Alkyds are distinguishable from other polyesters in that they contain fatty monobasic acids as "oil modifications" and are usually furnished in solvents. Because of popular usage, these polyester resins will be referred to as alkyds throughout the discussion of coating resins.

The predominant group of alkyd resins used in the manufacture of surface coatings employs phthalic anhydride as the main polybasic-acid constituent and such polyhydric alcohols as glycerol or pentaerythritol. Other polyhydric alcohols, such as glycols, di- or tri-pentaerythritol, sorbitol, or trimethylolethane, can be used to emphasize special resin properties. In addition to the polybasic acid and polyhydric alcohol components, alkyd resins for protective coatings are modified with oxidizing or non-oxidizing fatty acids derived from vegetable and, in some cases, marine oils.

Oil-modified alkyd resins of the air-drying type cure by oxidation of their drying oil constituent. In the case of the baking type, in which the oil modification may be oxidizing or non-oxidizing, the alkyds cure by co-condensation with alkylated amino resins in the presence of heat.

Quantitatively and qualitatively, the oil modification of alkyd resins produces profound effects on the properties of these products. Alkyds generally contain from 30 to 70% of oil and, depending on their specific range of oil content, are classified approximately as follows:

Classification	Oil content, %
Short-oil	30-46
Medium-oil	46-56
Long-oil	56-70

The general quantitative effect of oil content on alkyd resin properties is expressed graphically in Table IV, above, wherein the values of the various properties listed increase in the direction shown by the arrows. Broken arrows are used when the solvent has a bearing on the property.

Table V, p. 144, illustrates the qualitative effect of the type of oil used on the properties of the alkyd.

Short-oil alkyds

Short-oil alkyds contain fewer of the aliphatic, solvent-tolerant, fatty-acid chains in their molecular structure, and, hence, are prone to be incompatible in aliphatic solvents. These alkyds are supplied as solutions in aromatics, such as xylene or toluene. The short-oil alkyds that are modified with non-oxidizing oils, such as coconut or castor oil, are used as plasticizers in cellulose nitrate lacquer formulations to contribute the necessary properties of adhesion, flexibility, durability, and color retention to

TABLE V: Effect of type of oil on properties of alkyd resins[1]

	Speed of cure	Color	Gloss retention	Oil	Iodine value
DECREASE ←				Tung	170
				Linseed	180
				Dehydrated castor	155
	↑			Soya	135
				Cottonseed	110
				Castor	85
→ INCREASE		↓	↑	Coconut	9

[1] Adapted from "Paint and Varnish Technology," edited by William Von Fischer. 1948. New York: Reinhold Publishing Corp.

modern automotive and other fast-drying industrial lacquer finishes. Short-oil, non-oxidizing alkyds are also used extensively with urea and melamine resins in baking enamels and yield exceptionally hard, tough finishes for refrigerators, washing machines, home freezers, and many other similar types of home appliances.

Short-oil, oxidizing alkyds based on soya, dehydrated castor, or cottonseed oils have a broad base of utility in industrial baking finishes of all types. In conjunction with acid-catalyzed urea resins, they have also found successful application in forced-dry, wood-furniture finishes that are superior in abrasion resistance, impact strength, and durability to oleoresinous varnishes or cellulose nitrate lacquers.

Medium- and long-oil types

Medium- and long-oil alkyds that are soluble in mineral spirits are modified most frequently with oxidizing oils and are used in brushing-type, air-drying finishes. Many government specifications call for alkyds of this group and most of the familiar household paint products, such as alkyd, flat wall-paint, 4-hour high-gloss enamel, and porch, floor, and deck paints, are manufactured, at the present time, from either the medium- or long-oil type alkyd resins.

Availability of "odorless" and "low-odor" mineral spirits has permitted development of medium- and long-oil alkyd resin solutions in these solvents for interior alkyd-based flat paints and gloss enamels that are free from obnoxious odors. These products have shown a gain in usage in a market that only several years ago seemed to be headed toward complete domination by water-thinned latex paints. Long-oil and extra-long-oil alkyds at 100% solids are also increasing in usage as modifiers for various water-dispersed latices and as components of exterior house paints.

Modified alkyds

Oil-modified alkyd resins may be modified further by processing with other materials for the emphasis of special properties. Common modifiers (see Table VI, below) are rosin, phenolic resins, styrene, and silicones. Such additional modification, however, is usually a compromise in which some properties are gained and others lost.

Highly thixotropic alkyds have been developed by modification with polyamide resin. Paint products produced from polyamide-modified alkyds are unusual in appearance in that they are jelly-like, but are quickly reduced to ordinary consistency by mechanical agitation.

Non-phthalic alkyds

Rosin or terpenes, and maleic anhydride or fumaric acid undergo a Diels-Alder reaction and form a tribasic acid. This reaction product can be esterified with glycerol or fatty-acid glycerides to produce alkyd resins that exhibit properties superior to those of the varnishes manufactured by simply cooking maleic-modified ester gum with oils. Although these alkyds cannot be considered equivalent-quality substitutes for phthalic alkyds, they fit into a small sphere of utility for special applications.

Use of alkyd resins in the surface-coatings industry has risen considerably faster than the increase in paint production during the past 25 years. Alkyd resin production (solids basis) reached 241 million lb. in 1946; approximately 450 million lb. were produced in 1955 and probably close to 500 million lb. in 1956. This substantial growth is due to versatility, uniformity, and economy.

Versatility: Alkyds, in general are better coatings than oleoresinous varnishes and are adaptable to a wide variety of air-drying and baking finishes for wood, metal, plaster, paper, and plastics. In addition, alkyds function as plasticizers for cellulose nitrate.

Uniformity: The growth of al-

TABLE VI: Modifiers for alkyd resins

Modifying agent	*Advantages contributed*	*Disadvantages contributed*
Rosin	Fast drying Hardness Mar resistance	Yellowing Poor exterior durability
Phenolic	Hardness Solvent resistance Alkali resistance	Yellowing Poor stability
Styrene	Fast drying Light color Color retention	Poor solvent resistance Poor stability
Silicone	Heat resistance Hardness Resistance to thermal shock	Cost Higher curing temperature

kyd resin production has fostered development of a new scientific attitude in the paint and varnish industry. Careful chemical controls required for successful alkyd production have replaced the individual judgment of the varnish maker and a new order of uniformity has resulted.

Economy: Alkyd resins are low in cost. Their raw materials are available to the manufacturers in abundant supply. The efficiency of handling packaged, ready-to-use vehicles of high quality and wide scope represents a greater stride in progress than any that the paint-making industry has made throughout its entire history.

ALKYD MOLDING COMPOUNDS

When suitable polyester resins, capable of cross-linking, are properly compounded with fillers, pigments, and catalysts, thermosetting molding compounds result that have rather unique properties. Known as alkyd molding compounds, these materials are fast-curing and may be made to flow around delicate inserts in intricate shapes. Fast-closing presses are required and, depending upon the thickness of the part, cure times of 10 to 50 sec. are possible. Molding temperatures are usually in the range of 300 to 315° F., with molding pressure varying in the range from 800 to 1500 p.s.i.

Moldings exhibit excellent dimensional stability and electrical characteristics. Their arc resistance and elevated temperature service up to 400° F. are of particular interest. Moisture- and solvent-resistance is good.

The molding compounds may be filled with a mineral filler or reinforced with fibrous glass. The mineral-filled products are in both putty and granular forms. The putty form is particularly useful in encapsulating small electrical resistors and capacitors. The granular types are free-flowing and adaptable to automatic molding operations. Numerous electronic components, such as tuner boards, tube bases, and connectors, are in production. The granular types are also finding their way into automotive ignition applications.

The fibrous glass-reinforced materials are usually in mat form and are characterized by their high strength. These materials have found widespread use in applications where a combination of high strength and good electrical properties is important. Thus, these materials are used in such applications as insulating brackets and bases, rocker rings, circuit breaker cases, and coil forms.

The alkyd molding compounds are more reactive by nature than other thermosets and, therefore, are more sensitive to handling and storage conditions.

OTHER POLYESTER PRODUCTS

Included among other polyester products are the following:

Plasticizers: A number of polyester plasticizers are available commercially. In general, they are saturated resins of controlled molecular weight. The polyester plasticizers are more viscous and, because of their low volatility, are more permanent than other esters used for plasticizers. They may be used in both organic coatings and plastics.

Fiber and film: A special type of saturated polyester prepared from ethylene glycol and terephthalic acid has found application in the textile fiber field and as film. Clothing fabric woven with fibers (Dacron) of this polyester has good wear resistance and laundering characteristics. The film (Mylar) features well-known tensile strength and tear resistance and is finding ready application in electrical and packaging applications.

Polyurethane resins: Other saturated polyesters with lower molecular weights and differing compositions are entering the rapidly expanding field of polyurethane resins. The polyesters are used in conjunction with diisocyanate compounds to form foams and elastomers as well as coatings.

Saturated polyesters and diisocyanates of appropriate composition can also be reacted to form polyurethane elastomers capable of being cross-linked, by reaction with suitable agents, to form extremely tough and wear-resistant rubber products.

References

Consult the Subject Index for additional information concerning polyester (alkyd) resins. For specific information on low-pressure laminating, see p. 506; casting, see p 741. See also the Adhesives, Coatings, Foamed Plastics, Laminates, Low-Pressure Laminating Resins, and Plastics Properties Charts for information on properties and trade designations. For sources of polyester (alkyd) resins, see the Directory Index, p. 1018.

"Better conveyor belts for foods," MODERN PLASTICS *34*, 124 (Nov. 1956).

"Boiled in film," MODERN PLASTICS *34*, 136 (Oct. 1956).

"Reinforced molding compounds. Part 1. Polyesters and alkyds," MODERN PLASTICS *33*, 91 (Aug. 1956).

"Glass-polyester washing machine parts," MODERN PLASTICS *33*, 187 (July 1956).

"Alkyd molding materials," Brit. Plastics *29*, 354 (Oct. 1956).

"Critical temperatures of a series of peroxides in polyester resins," Brit. Plastics *29*, 377 (Oct. 1956).

"Polyester laminating resins; part I," by J. Brydson and C. W. Welch, Plastics (London) *21*, 282 (Oct. 1956).

"Alkyd molding materials and their applications," by J. H. Bennitt, A. L. Ashton, and D. M. Jonas, Plastics Inst. Trans. and J. *24*, 213 (July 1956).

"Storing and handling polyester resins in bulk," Plastics Tech. *2*, 400 (June 1956).

"Bonding of Terylene polyester fiber to natural and synthetic polymers," by T. J. Meyrick, Rubber and Plastics Age *37*, 394 (June 1956).

"Progress with alkyd molding powders," Plastics (London) *21*, 112 (June 1956).

Protein Plastics: Zein, Casein

Proteins belong to the category of high polymeric materials. Inasmuch as there are some 20 alpha-amino acids known to be constituents of proteins, there are that many possible monomers, the alpha-amino and adjacent carboxyl groups, which form the backbone of the polymers, while the other groups form the side chains. These side-chain groups include amino, amide, carboxy, aliphatic hydroxy, phenolic, guanidyle, indole, imidazole, thiol, and disulfide. They are apparently spaced regularly along the chains and vary greatly in amounts in the different proteins. These are the reactive parts of protein molecules and are responsible for fundamental differences between proteins and for the extreme complexity of these natural polyamides.

The fibrous proteins (keratins, such as horn, tortoise shell, hoofs, claws, hair, and feathers) resist solution and deformation by heat. The globular proteins (casein, soybean, and zein) readily dissolve and are thermoplastic.

Potentially low-cost proteins include soybean, zein, peanut protein, and keratins. Molding powders can be made from the reaction product of keratin-containing horn powder, urea, and formaldehyde. Peanut protein has suitable characteristics for use as glue. Soybean and peanut proteins are used as extenders of phenolic resin in plywood.

ZEIN

BY D. M. RATHMANN*

Zein belongs to the class of aqueous alcohol-soluble proteins known as prolamines. Although first isolated from corn in 1821, zein did not become commercially available until 1939. Applications since that date have taken advantage of its solubility in organic solvents and its film- and fiber-forming characteristics.

Like all proteins, zein is a naturally-occurring high polymer composed of amino acid groups united by peptide linkages. The high proportion of acidic, amide, and nonpolar side chains accounts for its solubility in many organic solvents.

Zein is a product of the corn wet-milling industry. Gluten, which contains most of the protein in the corn kernel, is separated from the starch and other constituents. Zein is then extracted from the gluten with organic solvents.

Processing and fabricating

Solutions of zein in organic solvents or aqueous systems are adaptable to a wide range of coating, film, and fiber applications. As a general rule, a solvent for zein must contain at least one functional group of the type hydroxyl, carboxyl, amide, or amine. Zein is unique among the industrially available proteins in being soluble in methanol, in aqueous ethyl and isopropyl alcohols, and in the lower-molecular-weight glycols and glycol-ethers.

Secondary solvents, which will not dissolve zein but which enhance its solubility in a primary solvent, include lower ketones, aliphatic esters, chlorinated hydrocarbons, and the higher glycol-ethers. These materials are particularly useful because they permit modification of such properties of zein solutions as evaporation rate or viscosity; they also promote the compatibility of various resins and plasticizers. Alcoholic solutions of zein tolerate limited amounts of diluents such as toluene, xylene, benzene, and naphthas.

Zein is insoluble in water but is readily soluble in aqueous alkalies at a pH of 9.5 to 11. Zein, unlike many other proteins, is not dispersed by weak alkalies such as ammonia or borax. Dilute aqueous solutions of strong alkalies dissolve zein but concentrated solutions do not. Useful aqueous systems are formed with ammonium or sodium resinates. Various synthetic detergents, such as the sodium alkyl aryl sulfonates, produce neutral aqueous solutions of zein having good film-forming properties. Methods have been developed for the preparation of emulsions that are neutral, stable water systems having high solids content and water-thin viscosity. Films prepared from these emulsions are comparable to those made from organic solutions.

Plasticizers for zein compositions include higher glycols, sulfonamides, fatty acids, amides, esters, and amines.

Fusion resins are made by blending zein with natural or synthetic resins and plasticizers. As in the case of solvents and plasticizers, resins containing highly polar groups and a proper balance between polar groups and hydrocarbon residues are fully compatible with zein. Many materials that may be classified as incompatible have been incorporated into zein systems by the use of mutual solvents, plasticizers, and resins.

Increased tensile strength, greater toughness, and higher water resistance are imparted to zein compositions by curing with formaldehyde. Because few primary amino groups occur in the zein molecule, reaction with formaldehyde proceeds at a slower rate than in the case of proteins containing these groups. Curing is accelerated by catalysts such as strong mineral acids or their ammonium salts, and by heat above 70°C.

Properties

Zein is the only industrially available protein soluble in organic solvents. This property gives the material many fields of application not open to other proteins. Zein is compatible with a wide range of natural and synthetic resins and plasticizers. In addition, it is soluble in dilute

* Corn Products Refining Co., 17 Battery Pl., New York, N. Y.

References were prepared by the editors.

aqueous solutions of strong alkalies, and is dispersed by various resinates and synthetic detergents.

Unlike most other proteins, zein is highly resistant to microbial attack. Films and coatings are tough, glossy, scuff-resistant, and greaseproof. Fibers have wool-like properties, high tensile strength, and notable resistance to acids, alkalies, and organic solvents.

General properties of zein

Molecular weight	about 25,000
Specific gravity (at 25° C.)	1.25
Isoelectric point	6.2
Dielectric constant	4.9–5.0
Decomposition point (° C.)	180–200

Applications

Vicara brand textile fiber is produced from aqueous alkaline solutions of zein by extrusion into acidic-salt hardening bath and curing with formaldehyde. Properties are described in the Fibers Chart.

Composition cork is produced by mixing cork granules with a solution of zein and formaldehyde in a glycol-type solvent. By application of pressure and heat, the zein is cured and set to a water-resistant binder. This composition cork is suitable for use in gasket sheets and bottle cap liners; it has excellent flexibility, compressibility, water resistance, and oil resistance.

Alcoholic solutions of zein and a compatible resin are particularly adapted to use as label and overprint varnishes which are tough, glossy, and scuff-resistant.

Highly grease-resistant and greaseproof coatings can be applied to paper and paperboard from solutions of zein. The zein emulsions are particularly suitable for the preparation of grease-resistant coatings on paperboard and avoid objections to the use of organic solvent systems.

Vehicles for various types of printing inks consist of zein (alone or modified with resins) dissolved in glycols or alcohol.

Fusion resins, made by blending zein with resins and plasticizers, may be ground to powders and either dissolved in solvents to give coating solutions or mixed with fillers to form molding powders.

CASEIN

Formaldehyde-hardened casein plastics were developed in Europe and their manufacture began there about 1900. Commercial development in this country did not get under way until after the original patents had expired. The basic patents covering the production of a tough, insoluble hornlike mass from casein by the action upon it of formaldehyde were taken out by two Germans, Krische and Spitteler, in 1900.[1]

Formaldehyde is the only agent which has as yet been economically successful in transforming casein into usable plastics. It is more accurate, therefore, to use the term casein-formaldehyde plastics than to call them casein plastics. Reaction with formaldehyde undoubtedly takes place through the polyamide groups and results in a cross-linked polymer.

Casein also reacts with aluminum salts in water solution to produce a stiffer, more stable material than casein itself. The casein-alum, unlike the casein-formaldehyde, is thermoplastic, hence may be extruded or molded with heat and pressure. Immersion in water breaks down the complex, leaches out the alum, and leaves the original casein.

Casein can be modified by acetic, propionic, and *n*-butyric anhydrides to produce derivatives that can be molded into articles having greater resistance to water. However, this reduction in water uptake is not entirely beneficial, since it is accompanied by a decrease in the strength characteristics of the molded casein articles.

[1] U.S. Patent 646,844; German Patent 127,942.

Manufacture

Conventional processing involves mixing ground rennet casein with water, dyes, and pigments; further processing in a screw extruder; extrusion as rods, tubes, or ribbons; hardening by immersion in a 5% formaldehyde solution for periods varying from a few days to several months (depending upon the dimensions of the piece); and drying. The cured plastic can be shaped somewhat with heat and pressure, and can be fabricated into a variety of end products.

Casein-formaldehyde plastics have generally good impact strength, some elasticity, and properties characteristic of thermosetting materials. A wide range of color effects is possible. Hygroscopicity and dimensional instability, however, have been limiting factors to their extensive application.

Forms available

Casein plastics are available in sheets approximately 16 by 20 in. by 2, 3, 4, and 6 mm. in thickness; other thicknesses up to 12 mm. are made to order. Standard size rods are approximately 41 in. long in diameters from ⅛ to ¾ in. inclusive. Rods smaller than ⅛-in. diameter are ground to size. Tubes are made to order in diameters up to 1 in. with bores of various diameters. Disks are available in any desired size from ⅜ to 2½ in. in diameter, varying from 2 to 8 mm. in thickness.

Special forms include button blanks, loops, rings, buckles, beads, game counters, and push-buttons, as well as handles and the like.

References

Consult the Subject Index for additional information concerning casein, zein, and other protein plastics. See also the Adhesives, Coatings, Fibers, and Plastics Properties Charts for information on properties and trade designations. For sources of these protein plastics, see Directory Index, p. 1018.

"Modernization of a casein plant," Modern Plastics *28*, 94 (Dec. 1950).

"Stabilization of zein filaments," by C. B. Croston, Ind. Eng. Chem. *42*, 482 (Mar. 1950).

"Zein: versatile packaging resin," Modern Packaging *22*, 122 (Aug. 1949).

Silicones

BY PAUL A. GOODWIN*

RECENT DEVELOPMENTS

A heat-resistant laminate (Swedlow Plastics Co.), designed for aeronautical applications, affords an efficient barrier to heat transfer at temperatures up to 1200° F. The laminate is composed of fibrous glass fabric, high-temperature-resistant silicone resin binders, combinations of highly reflective metalized surfaces, and inert substances for added resistance to surface corrosion.

A glass-silicone grade of laminated plastics (*G-7-2*, The Formica Co.) has greater hot strength and better color fidelity, less water absorption, lower wet power factor, and higher dielectric strength than laminates heretofore available. The material is useful in electrical and electronic applications.

Transparent silicone-based rubber is being tested by the Air Force as an interlayer in windshield glass of new supersonic airplanes. The high heat of air friction softens the flexible, transparent vinyl butyral now used as a windshield interlayer, making it incapable of preventing the glass from shattering if cracked. The new interlayer retains adequate strength up to 350° F. as compared to the 180° F. limit on present interlayers.

A silicone rubber (*Silastic 916*, Dow Corning Corp.) combines high strength with thermal stability. Parts or components fabricated from this material retain high tensile strength, elongation, and tear resistance in high-temperature service. It has the good electrical properties normally associated with silicone rubber and is serviceable from —130 to 500° F. The material is suitable for molding, laminating, extruding, or calendering and it can be hot-air vulcanized.

The insulation resistance of miniature 26-contact connectors molded from silicone material (*Dow Corning 301 Molding Compound*, Dow Corning Corp.) was initially higher than comparable parts molded from mineral-filled melamine, glass-reinforced alkyd, and Orlon-filled diallyl phthalate. This advantage increased after exposure for 240 hr. at 96% relative humidity and room temperature.

The history of the silicones began in the 1870's with the work done by research chemists such as Landenburg in Germany and, later, Grignard in France. Earlier, silicon metal had been discovered in 1824 by Berzelius and the first organosilicon chemicals had been synthesized by Friedel and Crafts around 1863. Research done by Prof. F. S. Kipping in England around the turn of the century laid the foundations of silicone chemistry as we know it today, but it remained for General Electric Co. and Corning Glass Works chemists, working in the 1930's, to refine techniques and make the production of organosilicon compounds commercially feasible.

The silicones form a group of synthetic materials whose chemical structure contains both organic and inorganic linkages to produce many of the most desirable properties of both. Silicones exist in a wide range of physical forms from simple mobile fluids, through greases and flexible rubbers, to hard, durable resins of complex structure.

The unique properties of silicones have qualified them for many applications in almost all major industries. Some of the more important applications for the different classifications of silicones are shown in Fig. 1, p. 151. Uses such as cosmetics or automobile polishes, while important, are not directly of interest to the plastics industry. As a class, the silicones have the following outstanding properties: 1) stability to high temperatures; 2) retention of properties at extremely low temperatures; 3) resistance to weathering and oxidation; 4) good dielectric properties; 5) durable water repellency; and 6) chemical inertness. While most silicones show outstanding abhesive properties and are used in release applications, some are excellent adhesives for most materials.

Structure

The term silicone is generic for all organopolysiloxanes. Structurally, organopolysiloxanes are compounds containing a skeleton of alternating silicon and oxygen atoms with organic groups also attached to the silicon.

Physical properties of the silicones depend upon the nature of the organic groups, the ratio of organic groups to silicon atoms, the molecular weight, and the detailed molecular architecture. Silicones may be linear, branched, or cross-linked. Dependent on these factors, a silicone may be a fluid, elastomer, or thermoset resin.

Manufacturing processes

Regardless of physical form, most silicone polymers are produced by the hydrolysis and condensation of organosilicon halide intermediates. The intermediates may be produced by various methods. Simplified examples are shown on facing page.

The direct process, involving the reaction of methyl chloride and silicon metal to produce methylchlorosilanes, is the simplest process for producing methylsilicones in high yield. Phen-

*Manager, Technical Service, Silicone Products Dept., General Electric Co., Waterford, N. Y.
Recent Developments and References were prepared by the editors.

ylchlorosilanes can be produced by any of the aforementioned methods.

The familiar principles of organic polymer chemistry also apply to the design and production of silicone polymers. Thus, silicone fluids are short-chain polymers whose molecular weight is controlled by the amount of monofunctional units included in the condensation as chain stoppers. Elastomers are linear polymers of high molecular weight that are capable of vulcanization after compounding with reinforcing fillers. Resins are produced in a reactive "B-stage," by partial condensation of di- and trifunctional monomers. They are cured by heat and catalysts.

Because of the wide variety of silicone polymers and their many applications, it is impossible to describe all of the processing and fabricating techniques. Here again the processes used on organic polymers apply and, in general, conventional processing equipment can be used although high curing temperatures may be required.

Silicone fluids may be emulsified in water by conventional techniques to provide stable, aqueous emulsions. Compounding with finely divided fillers or stable soaps yields greaselike compounds.

Resin solutions may be milled with pigments in the same manner as organic resins to formulate paints and enamels. Alternatively, they may be combined with fibrous fillers for molding or used as bonding agents for glass cloth for laminating.

Elastomers are compounded with a wide variety of reinforcing fillers and vulcanizing agents in conventional compounding equipment to yield silicone rubbers of almost any desired combination of properties.

Silicone rubbers

The commercial availability of silicone rubber has given the design engineer materials that provide the peculiar properties of rubber under conditions not before possible. The major features of silicone rubber distinquishing it from other elastomers are:

1) Resistance to temperature extremes far beyond the limits of all other known rubbers (—150 to 600° F.).

2) Superior resistance to compression set throughout its entire useful temperature range.

3) Unequaled resistance to ozone, aging, and sunlight.

4) Good chemical resistance, making it odorless, tasteless, noncorrosive, nonstaining, and nonsticking.

5) Good electrical properties which are maintained at elevated temperatures.

Silicone rubber materials are available in consistencies for molding, calendering, caulking, sponging, laminating, and wire covering. Dispersions are also available for coating operations.

While all silicone rubber compounds in general possess the features outlined above, the rapidly expanding technology has made possible the classification of the many available recipes according to predominant properties. Presently available silicone elastomers fall into one or more of the following classifications: 1) general purpose; 2) low compression set; 3) extreme low temperature; 4) extreme high temperature; 5) wire and cable; and 6) pastes. The first four classes are based on cured physical properties while the last two are based on processing requirements. The property differences upon which the first four classes are based are outlined in Table I, p. 150.

The fabricator of silicone rubber components has commercially available to him raw silicone rubber compositions in each of these classes. In addition he has available pure silicone gum polymers of various types that may be compounded into the desired type of composition. The silicone polymer determines the basic classification while other compounding components, such as fillers, curing agents, and additives, determine characteristics such as the degree of reinforcement and processability.

The characteristics of silicone rubber and the variety of types processable by practically any technique standard for the rubber industry have dictated their use in an amazing variety of commercial applications. The major application categories are outlined below:

Aircraft industry: Various airframe applications take advantage of the low-temperature flexibility. Engine components take advantage of high-temperature compression set and resistance to various fluids.

Appliance industry: Advantage is taken of high-temperature compression set and maintenance of good electrical characteristics over a wide range of temperatures.

Electrical industry: Silicone rubber meets the requirement for extruded insulation and insulation tape, both supported and unsupported. Silicone rubber also finds use in many molded and ex-

COMMERCIAL PROCESSES FOR MANUFACTURING ORGANOCHLOROSILANES

Direct Process

$$2CH_3Cl + Si \rightarrow (CH_3)_2SiCl_2$$

Grignard Process

$$2CH_3Cl + Mg \rightarrow 2CH_3MgCl$$

$$2CH_3MgCl + SiCl_4 \rightarrow (CH_3)_2SiCl_2 + 2MgCl_2$$

Silicon Hydride-Hydrocarbon Process

$$3HCl + Si \rightarrow SiHCl_3 + H_2$$

$$SiHCl_3 + (C_2H_4) \rightarrow C_2H_4SiCl_3$$

Wurtz Process

$$2CH_3Cl + SiCl_4 + 4Na \rightarrow (CH_3)_2SiCl_2 + 4NaCl$$

truded parts, included among which are such items as bushings, seals, and spacers.

Miscellaneous: Other applications range from nursing bottle nipples to parts for handling hot glass. In these applications advantage is taken of the general inertness to the effects of extremely high temperatures and exposure to many assorted media.

Molding compounds

High-impact, glass-filled silicone molding compounds are adaptable to compression or transfer molding. Molded parts have a heat distortion point greater than 900° F. and retain exceptionally good physical and electrical properties in service at temperatures well above 400° F. At 400° F., for example, the flexural strength is 6000 p.s.i. and the compressive strength is 4000 p.s.i.

Laminating resins

Silicone laminating resins are ordinarily used with glass fabrics because the finished laminates are intended for high-temperature operation. Resins are available for either high-pressure or low-pressure fabrication techniques. Silicone laminates have exceptional high-temperature stability and retain a much higher percentage of their room-temperature strength at elevated temperatures. They are characterized by excellent electrical properties even after prolonged immersion in water or at elevated temperatures.

Low-pressure laminates have flexural strengths of 30,000 to 50,000 p.s.i. at room temperature, 15,000 to 20,000 p.s.i. at 500° F; dissipation factor after 24 hr. immersion in water is about 0.0008 at 10^5 cycles.

High-pressure laminates retain dielectric strength of 400 v./mil after 5000 hr. at 500° F., and a dissipation factor of 0.044 at 10^5 cycles after 24 hr. immersion in water. Flexural strength at room temperature is in the range of 24,000 p.s.i.; at 500° F., the flexural strength is approximately 4500 p.s.i.

Foam resins

Ready-to-use foaming powders require no mixing nor addition of catalyst or blowing agent. They expand on heating at moderate temperatures to produce rigid, low-density, nonflammable foam structures with a heat distortion temperature of 700° F. Thermal conductivity is 0.3 B.t.u./hr./sq. ft./° F. for 1-in. thickness. Water absorption, after 24-hr. immersion, ranges from 2 to 4 percent. Weight loss, after 1000 hr. at 500° F. is less than 4 percent. Good dielectric properties are retained in service at elevated temperatures.

Release agents

Silicone release agents are available as 100% silicone fluids, as water-dilutable emulsions, as greases, or as solvent solutions. They are chemically inert and heat stable; therefore, there is no chemical attack on molds or molded parts and no carbonaceous build-up of release agent on molds. Because of their low surface tension they give rapid, complete mold coverage, and because of their low volatility they reduce smoking and stay in place.

Silicone release agents provide better-appearing parts, both in surface finish and detail, longer mold life, and lower mold clean-out and maintenance costs. They are used on compression, injection, and transfer molds, extrusion dies, laminating plates or forms, and embossing rolls. They are also used in release of glass and metal castings.

Lubricants

Silicone lubricants are available either as fluids or greases which cover an operating range from —100 to 450° F. They offer product designers the opportunity of creating new equipment of improved performance, using designs previously considered impossible because of the limitations of conventional lubricants. They substantially reduce maintenance and relubrication costs.

Applications for silicone lubricants include rotating electrical equipment (motors, generators, etc.) designed for high- or low-temperature use, clocks or timers, conveyor systems, and others.

Outstanding properties include thermal stability (over 500 hr. at 400° F. in air without gelation), low viscosity-temperature coefficient, excellent stability to oxidation, and low volatility (less than 1% weight loss in 3 hr. at 200° C).

Silicone greases, in addition to lubrication uses, are used as dielectric compounds and mold release agents.

Adhesives

Silicone adhesives are used where excellent adhesion is required coupled with such inherent properties of silicones as unusually high moisture resistance, thermal stability, low-temperature flexibility, chemical inertness, and resistance to aging.

Silicone adhesives may be used in conventional bonding operations or as pressure-sensitive adhesives on tapes or fibers. Such pressure-sensitive adhesives remain tacky and flexible from —80 to 500° F., and they retain good adhesive properties for long periods at high temperatures. They provide excellent bonds to such materials as metals, glass, paper, silicone rubber, and plastics, including such difficult-to-bond materials as Teflon and polyethylene.

When a suitable backing is used, silicone pressure-sensitive tapes combine good dielectric properties with resistance to thermal aging and to moisture. They are used in a wide variety of electrical and electronic applications, as well as

TABLE I: Properties of classes of silicone elastomers

Class	*Durometer range*	*Tensile strength range*	*Elongation range*	*Typical comp. set, 22 hr. at 300° F.*	*Min. useful temp.*	*Min. useful temp.*
		p.s.i.	*%*	*%*	*° F.*	*° F.*
General purpose	40-80	500-1000	100/400	50	—70	500
Low compression set	50-90	500-1000	100/200	15-30	—70	500
Extreme low temp.	40-80	500-1000	100/400	60	—150	500
Extreme high temp.	40-80	500-1000	100/300	60	—70	600

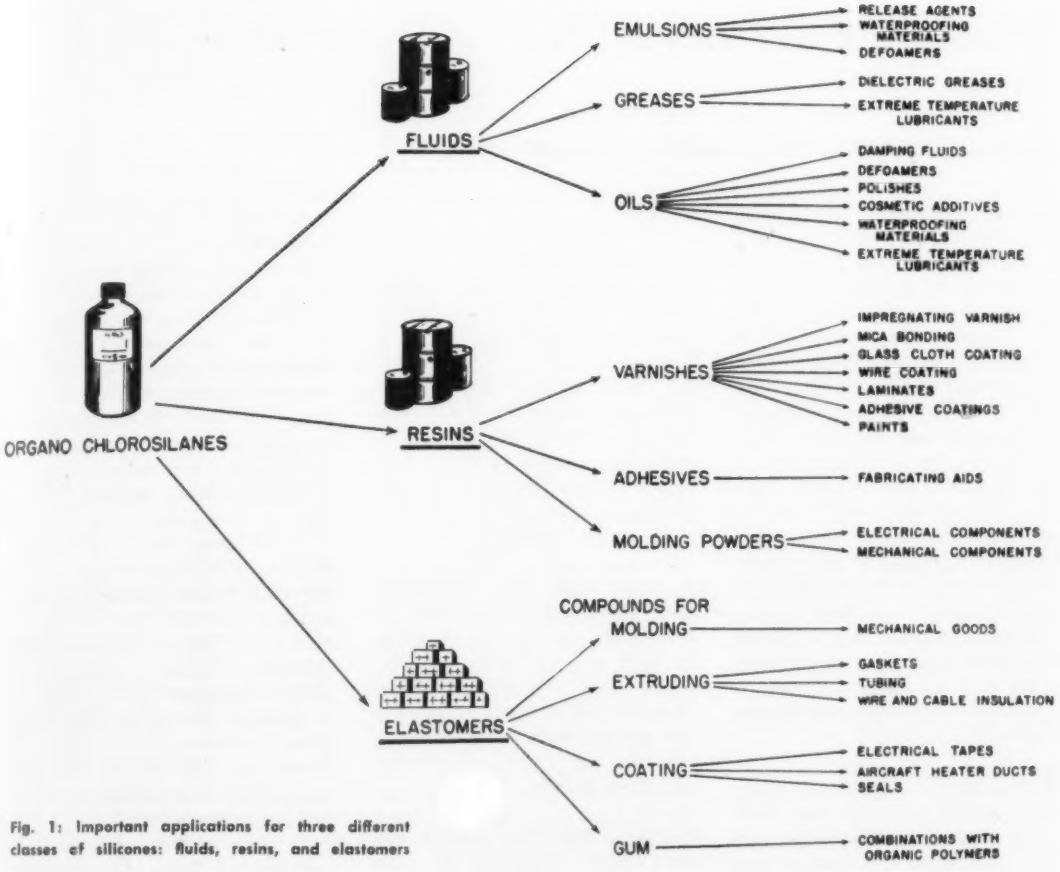


Fig. 1: Important applications for three different classes of silicones: fluids, resins, and elastomers

in mechanical applications where resistance to heat, moisture, or weather is important.

Miscellaneous

Silicone resins, used in combination with inorganic materials such as glass, mica, and asbestos provide operation of electrical equipment at Class H temperatures with a permissible continuous "hot spot" of 180° C. Much Class H insulation will withstand long service at 250° C. Electrical applications for silicone resins include their use as dipping and impregnating varnishes, mica-bonding resins, saturants for glass-served wire, cloth-coating resins, and water repellents.

Under the same operating conditions silicone Class H insulation has a service life many times as long as Class B (135° C. hot spot) insulation and provides greatly increased overload capacity.

Silicones are among the most effective and versatile defoaming agents available, and silicone antifoams have found applications in many parts of the plastics industry. For example, silicone antifoams are used to suppress foaming during stripping of resin or rubber latices after polymerization, and to prevent the inclusion of foam in latex articles.

The addition of small quantities of silicone fluids to plastisol formulations has been reported to reduce blocking and improve the surface slip of finished items.

References

Consult the Subject Index for additional information concerning silicone polymers. See also the Adhesives, Coatings, Laminates, Low-Pressure Laminating Resins, and Plastics Properties Charts. For sources of silicones, see Directory Index, p. 1018.

"Silicone alloys—new engineering materials," by C. L. Petze, Jr., Modern Plastics *33*, 207 (June 1956).

"Heat-resistant silicone foams," by D. E. Wever and K. R. Hoffman, Modern Plastics *31*, 133 (May 1954).

"Swelling of silicone elastomers," by R. L. Hauser, C. A. Walker, and F. L. Kilbourne, Jr., Ind. Eng. Chem. *48*, 1202 (July 1956).

"Silicones step lively," Chem. Eng. News *34*, 2798 (June 4, 1956).

"Silicones for the plastics industry," Brit. Plastics *29*, 158 (May 1956).

"Silicone rubber — properties, forming, applications," by S. K. Moxness, Prod. Eng. *27*, 173 (Mar. 1956).

"Copolymerization of vinyl silanes," by B. R. Thompson, J. Polymer Sci. *91*, 373 (Feb. 1956).

"Effect of glass fibers on cure of silicone resins," by H. A. Clark and K. R. Hoffman, Ind. Eng. Chem. *48*, 104 (Jan. 1956).

Styrene Polymers and Copolymers

RECENT DEVELOPMENTS

A styrene-acrylonitrile copolymer (*Polyflex 230*, Plax Corp.), which is biaxially oriented by unique extrusion methods, is available in standard width sheets of 21 and 42 in. and gages from 0.003 to 0.020 inch. The biaxial orientation of this material imparts toughness and provides for long life and economy in thin film form. It is unaffected by temperatures as high as 185° F. and as low as −60° F. It is virtually unaffected by ultra-violet from sunlight and although it transmits infra-red rays, it holds back "earth radiation" in the 40° to 150° F. range. It is recommended for use in greenhouse construction, in storm window manufacture, and wherever a low-cost outdoor-weathering plastic film is needed.

A medium-impact styrene molding material (*Lustrex LHA Natural*, Monsanto Chemical Co.) was developed for applications which require greater impact strength than general-purpose styrenes can offer and greater clarity than is possible with the high-impact styrenes. In the packaging field where clarity and toughness are equally important, this material provides an optimum combination of physical properties.

Solid-solution plastic fluors (Cadillac Plastic & Chemical Co.) for use in scintillation counters are cast alloys of polystyrene with small percentages of *p*-terphenyl and tetraphenylbutadiene. The fluors are available in rod form in diameters from 3 to 18 in. and in lengths up to 3 feet. They are said to be superior to the commonly used crystal phosphors in hardness, machinability, and chemical stability.

A high-impact, styrene-type molding compound (*TMD-5161*, Bakelite) has a heat distortion point in the range of 190 to 195° F. It is designed for electrical appliance housings that must withstand rough handling.

A new grade of high-impact polystyrene material (*Super 44*, Kleestron, Ltd.), for injection molding and extrusion, has improved flexibility and resistance to shock, allows molding in thinner sections with fewer supporting ribs, and permits undercuts and deep draws.

A polystyrene-cased storage battery (Exide Industrial Div., The Electric Storage Battery Co.) for emergency lighting has been approved by Underwriters Laboratories, Inc. Previously U/L accepted storage batteries only if encased in glass or opaque vulcanized rubber.

Extruded styrene copolymer sheet (Campco Div., Chicago Molded Products) has improved strength and color and can be obtained in sizes up to 3/16 in. thick. It is free from internal strain and can be readily formed into complex shapes and deep draws. It may be used for automotive applications.

While polystyrene was discovered in 1839, it was not produced commercially until 1935. Since its rise in commercial availability and popularity, many improvements have been made in the properties of the material.

Styrene monomer is the principal raw material from which styrene polymers and copolymers are made. Styrene may be polymerized alone or it may be copolymerized with other monomers by bulk, suspension, emulsion, or solution processes.

Molding: Advanced techniques in these polymerization processes and in compounding have resulted in the development of a broad range of styrene materials for molding. Each of these materials offers a specific combination of physical properties and behavior characteristics that enable it to be used economically for producing parts to satisfy specialized service requirements in certain areas of use. Heat-resistance, chemical-resistance, toughness, stability, etc., will vary among the various available styrene materials.

In addition, styrene materials are available with various combinations of flow and set characteristics suitable for optimum molding of parts according to wall thickness. When selecting the grade of styrene to be used for a specific job, the molder must take into account this balance of "flow" and "set" attributes, with wall thickness generally affecting the choice as follows:

1) Thin sections (up to approximately 0.045 in.)—Flow to be emphasized (particularly for large-area moldings) with sacrifice in set. Short heat travel path and cold molds minimize cooling time.

2) Medium sections (0.045 to 0.075 in.)—Compromise of good flow and good set.

3) Heavy sections or mixed thick and thin sections—Fast or high-temperature set to be emphasized with flow more or less sacrificed.

Extrusion: Diversification of styrene extrusion materials has not developed to the same extent as in the styrene molding materials. Most extruded products are made from a distinct "extrusion grade" (usually without surface lubricant) in each class of polymer or compound. In the fast-growing field of sheet extrusion with rubber-modified compounds, the beginnings of a trend toward

---

THIS ARTICLE IS BASED PRIMARILY ON INFORMATION SUPPLIED BY KOPPERS CO., INC., PITTSBURGH, PA.

Other contributions by: Bakelite Co., Catalin Corp. of America, The Dow Chemical Co., and Monsanto Chemical Co.

Recent Developments and References were prepared by the editors.

more specialized compounds can be detected in the appearance of separate compounds emphasizing gloss, toughness, or enhanced output rates.

Types of styrene

Among the classes of styrene polymers, copolymers, and compounds are: 1) general-purpose (or polystyrenes and polystyrene compounds); 2) heat-resistant; 3) light-stabilized; 4) glass-reinforced molding compounds; 5) impact types (or rubber-modified polystyrene compounds, styrene-rubber plastics, etc.); 6) chemical-resistant copolymers (or styrene - acrylonitrile copolymers); and 7) polymers and copolymers of alkyl-substituted styrenes. (All of these polymers are available in pellet or granule form and with various internal and/or external lubrication agents best suited to the product-forming process and equipment to be used.) Special processing techniques and compositions have also made the following added forms of styrene available: 8) oriented polystyrene and styrene-acrylonitrile copolymers; and 9) expandable and expanded polystyrene foams.

General-purpose polystyrenes

Actually, in view of the diverse range of polystyrenes and polystyrene compounds now available, the description "general-purpose" has become a misnomer. The term, however, still persists and is widely used.

Many outstanding features are responsible for making polystyrene one of the most popular of plastics. It is the lightest in unit weight of present commercially available rigid plastics. Because the basic resin is colorless, the polymer can be made crystal clear or in an unlimited range of colors —from transparent to opaque. Excellent dimensional stability combined with negligible moisture absorption (even after long-term immersion) and freedom from warping or distortion within the thermal operating range of each grade make the polystyrenes useful where molding to close tolerances is required.

Polystyrene is free from taste and odor, nontoxic when used in contact with food, and does not support growth of molds or fungi. Its resistance to corrosive chemicals and their aqueous solutions, such as acids (except oxidizing acids), alkalies, salts, and lower alcohols is outstanding. Electrical properties are exceptionally good over the whole range of frequencies in practical use.

Applications: Disposable packaging for all sorts of merchandise, along with dispensing dishes and utensils for foods, are the fastest-growing high-volume uses for polystyrene. Refrigerator parts (e.g. crisper trays, meat keepers, butter dishes, etc.,), emblems, signs and displays, and packaging applications of a more permanent nature all use polystyrene because of its physical advantages as well as the fact that it lends itself so well to decoration. Decalcomania, hot-stamping, wipe-in painting, metalizing, lacquering, and silk screen printing techniques have all been adapted to polystyrene. Toys, game pieces, novelties, combs, brush-backs, wall tile, many housewares for use with cool foods, flower pots, and planters are all made advantageously from polystyrene. Special compounds are used in phonograph records.

Heat-resistant polystyrenes

For satisfactory service in high-temperature atmospheres, e.g. in heavily-illuminated display windows or cases or in closed automobiles kept out in the hot summer sun, heat-resistant polystyrenes have proved themselves over the past nine years. Parts molded of heat-resistant polystyrene show good retention of dimensional stability in boiling water, but cannot really be called "boilable." Coincident with improved heat resistance, these grades have enhanced physical properties that often dictate their use even where heat resistance is not in question.

As contrasted to easy-flow materials, the heat-resistant polymers reach moldable plasticity and set up in molds at higher temperatures. This behavior makes molding machines with plasticating capacity and good mold temperature control in the range of 130 to 180° F. necessary for quality economical production. To realize the full potential in strength and heat resistance, however, annealing may be required in some cases. Slow cooling after annealing prevents introduction of new thermal stresses.

However, annealing only increases the heat distortion of a piece when measured under load such as by the A.S.T.M. test. It does not appreciably improve use temperature when the distortion of a piece due to shrinkage or other stress relaxation is the determining factor, as it is in many applications.

Under some circumstances, it is possible to run faster molding cycles with these heat-resistant grades than with normal polystyrenes. Because set-up is so rapid, these grades are especially adaptable to the molding of heavy sections. Because of their high-strength characteristics, heat-resistant grades are also often preferred for the extrusion of rods, tubes, profiles, wall coverings, etc.

Applications: With the same coloring and decorating potential as normal polystyrenes, the heat-resistant polystyrenes have been extensively used in table model radio cabinets, TV lenses or front panels, clock cases, watch and jewelry packages, storage battery cases, camera housings, appliance panels and handles, illuminated signs and displays, fluorescent lighting fixtures, housewares to withstand unusual stress or hot food contact, and reels and spools for film and tapes.

Light-stable polystyrenes

Normal polystyrenes do not resist outdoor weathering sufficiently to warrant use in permanent outdoor installations. Exposure to ultra-violet light from direct sunlight or artificial sources causes polystyrenes to develop a yellowish straw cast and eventually become brittle. Light-stable formulations, which, by test under ultra-violet light sources, show substantial improvement in such behavior, have therefore been developed. However, the degree of stability is not so great that stabilized polystyrenes can be recommended for outdoor uses. On the other hand, light-stable

polystyrenes are finding increasing use in molded and extruded indoor lighting fixture diffusers and in packaging to protect contents from discoloration or spoilage from ultra-violet light exposures. In some cases, improved light stability is achieved with some sacrifice of heat resistance or strength characteristics. In other instances, the light-stabilized formulations are slightly limited in colorability, making it difficult, for example, to produce clean translucent bluish-white.

Although initially slightly yellow, styrene-acrylonitrile copolymers show less change upon exposure to light than do the normal polystyrenes.

Glass-reinforced polystyrenes

Fibrous glass-reinforced polystyrene is made for the production of strong, rigid pieces with superior dimensional stability. The normal method of manufacture is by injection molding. Compression molding or extrusion techniques ordinarily do not result in the entanglement and felting of the glass fibers which is necessary to realize the full reinforcing potential of the fibers. Compounds usually contain about 35% glass by weight; some have been made up to 50 percent. The 35% compounds typically have heat distortion temperatures in excess of 215° F., tensile strengths about 10,000 p.s.i., and mold shrinkage of only 0.001 in. per inch.

Glass-reinforced polystyrenes are either supplied in slightly translucent to opaque colors or in an off-white natural that may be dry-colored by the molder. Some decorative value can be achieved by mixing these polystyrenes with transparent, heat-resistant polystyrenes. Service or appearance requirements of certain applications may be satisfied by mixing the glass-reinforced polystyrene pellets with heat-resistant polystyrenes or heat-resistant rubber-modified compounds to reduce the glass content.

Applications: Typical applications which take advantage of the toughness, rigidity, and the superior heat resistance of glass-reinforced polystyrenes are: tape reels, blower wheels, textile bobbins, housings, and military devices that have to be able to withstand rough usage.



Light-stable polystyrenes are finding increasing use in molded diffusing pans for fluorescent fixtures. (Photo, Sheffield)

Impact-type polystyrenes

With the rise in popularity of polystyrene and the widening of its markets, it soon became evident that the toughness of normal polystyrenes was inadequate for successful use in some fields. Research resulted in so-called "impact polystyrenes," or rubber-modified compounds. These materials are characterized by improved shock resistance and increased elongation, while still retaining good electrical and mechanical properties.

There are three general classes of products in this category—medium-, high-, and super-impact materials—with increasing shock resistance or toughness shown in each classification. As with normal polystyrenes, impact materials are available with various combinations of flow and set characteristics suitable for optimum molding of parts according to wall thickness. Other compounds combine improved heat resistance and strength with the toughness imparted by the rubber content. Thus, selection of a rubber-modified polystyrene can be made with an eye to service requirements and economy.

As a consequence of increased elongation and impact properties, the high-impact polystyrenes can be molded around metal inserts without later development of crazing or cracking. These improvements also permit machining and drilling of parts without the use of some of the precautions necessary with normal polystyrenes. The high-impact materials may also be punched on automatic machines, which is not possible with normal polystyrenes. Annealing is seldom required.

Impact materials are naturally translucent, limiting colorability to translucents and opaques. They are normally supplied as pellets, but granules or "fine grinds" are available in natural for dry-coloring. Compounds are usually externally lubricated for molding, unlubricated for extrusion.

Special high shock-resistant extrusion compounds specifically suited to the growing sheet markets are also available. These sheets are extruded in thicknesses from 0.010 to 0.250 in. and widths up to 60 inches. Extruded sheet is generally used for the thermoforming of large refrigerator parts and advertising displays requiring detailed features. Extruded striated sheet is used for decorative wall covering.

Applications: Successful applications for rubber-modified polystyrenes include toys, novelties, signs, and displays; radio cabinets, television masks, small appliance handles, and knobs; refrigerator and freezer door liners, spacers, trim strips, pans, and bins; air conditioner panels and grilles; disposable packaging, closures, food and drink dispensing dishes, and utensils; housewares, furniture drawers, and wall coverings; storage battery cases, tote boxes, shipping trays, and housings.

Chemical-resistant styrene copolymers

Many common household and industrial articles must withstand contact with substances that attack polystyrenes, such as aromatic, aliphatic, and chlorinated hydrocarbons, organic acids and esters, essential oils, and fats. To meet this need, copolymers of styrene and acrylonitrile have been developed.

In many of the uses for this type of resin, the mechanical properties are more important than the chemical resistance. While not a high-impact resin, its mechanical properties are

superior to ordinary polystyrene. This results in greater practical toughness, which, combined with clarity, accounts for many of the uses of the styrene-acrylonitrile resins. While the chemical resistance of the styrene-acrylonitrile copolymers is dependent only on the acrylonitrile content, the mechanical properties are better for the higher-molecular-weight resins at some sacrifice in molding plasticity. Thus, among the styrene-acrylonitrile resins available commercially, there are significant differences in their practical toughness under use conditions. Pieces injection molded from all polystyrenes are weaker when stressed parallel to the lines of orientation than when stressed across the orientation. But in styrene-acrylonitrile copolymers, this difference is less than for polystyrene, resulting in stronger pieces when stressed across the orientation. Usually, electrical properties and water absorption are slightly impaired, as compared to normal polystyrenes.

Pelleted injection and extrusion grades of these materials are supplied. Natural styrene copolymer resin is a pale straw color; transparent tints to opaque colors are also available. These copolymers are incompatible with polystyrene and its compounds.

Applications: Principal uses are housewares (dishes, tumblers, and cutlery handles); hair curler pins and cosmetic packaging; fountain pen barrels; battery cases and radio cabinets; sight glasses for pressure oil systems and oil dispensing devices; and laboratory utensils.

Polymers and copolymers of alkyl-substituted styrenes

Certain homologues of styrene have been known for many years to form polymers with notably higher heat distortion temperatures than are attainable from styrene itself. However, use of any higher-molecular-weight monomer does not guarantee this result. Commercialization in this area has been impeded by the unavailability of suitable low-cost monomers and their generally slower polymerization rates. Alpha-methyl styrene and specific mixtures of o-, p-methylstyrene (vinyltoluenes) are the first of these monomers to become available at low cost. A methylstyrene polymer and its copolymer with acrylonitrile, announced in 1956, was undergoing trade introduction and evaluation during scale-up to production capacity during 1957. In general, these can be expected to find a place in applications similar to those now satisfied by older heat-resistant polystyrenes or chemical-resistant copolymers, but where the service temperature is expected to be exceptionally high, or an added measure of toughness is desired.

Oriented polystyrene

When stretched in the fluxed state while cooling, polystyrene develops increased strength up to three-fold in the direction of stretch. Uni-directionally oriented polystyrene and chemical-resistant copolymer filaments are widely used as bristles for brooms and dusters as well as scrub brushes, utility brushes, and even inexpensive tooth brushes. When dry, the static charges developed by the brushing operation assist in causing lint and dust to adhere to the bristles. The adhesion, however, is not so strong that particles cannot be readily shaken or rinsed off.

Bi-directionally oriented polystyrene film is produced by stretching the fluxed plastic simultaneously laterally and longitudinally. The film can be as thin as 0.005 in., used chiefly for electrical capacitors. Film of 0.001-in. thickness is used for laminating to impact-type polystyrene sheet to retain gloss after vacuum forming. Oriented polystyrene of 0.015-in. thickness is used to form Venetian blind slats. Intermediate thicknesses are finding wide application in the packaging and luminous ceilings fields as well as in coaxial cable spacer wrap. A biaxially oriented styrene-acrylonitrile copolymer film for greenhouse construction, storm windows, etc., is also available.

Polystyrene foams

Polystyrene foams are available in two types—free-flowing granules which are expanded in place, and logs or planks from which shapes are machined. Both types of foam are available at densities below 2.0 lb./cu. foot. Both exhibit very low water-vapor transmission, low water absorption, low thermal conductivity, and good structural strength. Expanded polystyrene may be bonded to itself as well as to metals, glass, wood, and other solids. Polystyrene foam can be shaped by common machining operations, such as sawing and drilling.

References

Consult the Subject Index for additional information on styrene polymers and copolymers. For specific information on injection molding, see p. 650. See also the Adhesives, Coatings, Films, Foamed Plastics, and Plastics Properties Charts for information on properties and trade designations. For sources of styrene resins, see the Directory Index on p. 1018.

"Luggage is going places with copolymer sheet," MODERN PLASTICS *34*, 126 (Nov. 1956).

"Durability of modified polystyrene," by L. Gilman, K. T. Carolan, and M. Resnick, MODERN PLASTICS *34*, 176 (Sept. 1956).

"Protective coatings for polystyrene," by J. A. Snyder, C. F. Martino, J. R. Wilkinson, and E. H. Wood, MODERN PLASTICS *33*, 252 (June 1956).

"Revere sticks to plastics," MODERN PLASTICS *33*, 95 (Mar. 1956).

"Polystyrene manufacture," Plastics (London) *21*, 261 (Oct. 1956).

"Production of sheet from toughened polystyrene," by D. G. Peacock, Brit. Plastics *29*, 369 (Oct. 1956).

"Improved impact polystyrenes," by S. D. Eagleton, Plastics Inst. Trans. and J. *24*, 250 (July 1956).

"Consideration of some basic faults in polystyrene molding. I. Heat considerations," by M. Fuzzard, Brit. Plastics *29*, 176 (May); "II. Packing and stressing," ibid. 217 (June 1956).

"Compounding and processing styrene copolymer resins," by R. J. McCutcheon and K. K. Fligor, Plastics Tech. *2*, 95 (Feb. 1956).

Styrene Alloys

BY P. M. ELLIOT* and R. F. McCABE*

RECENT DEVELOPMENTS

Styrene - butadiene copolymer latex (*Dylex K-52,* Koppers Co., Inc.) is available for coating of printing paper. The latex has good compatibility with starch, dextrin, and protein adhesives. It may be used alone or in combination with natural adhesives and clays to improve printability and ease coating problems.

An improved modified styrene resin in pellet form (*Plio-Tuf P100,* Goodyear Tire & Rubber Co., Chemical Div.) can be injection molded and extruded with conventional equipment. Its uniform size permits accurate metered feeding and promotes an even distribution of heat through the material. Items made of this resin have good stiffness and high-impact strength, even at low temperatures. They are essentially inert to chemical attack and have good resistance to high heat.

Styrene-butadiene resin (*Plio-Tuf,* Goodyear) is calendered into sheet (Charles Crowl Co.) for thermoforming such products as airplane and auto parts, machine covers, display panels, window frames, and refrigerator door liners. The toughness of the sheet resembles that of the super-impact modified styrenes. It runs faster on a calender than other rigid-type sheetings.

A 98-mile styrene alloy (*Kralastic,* Naugatuck Chemical) pipe line (Republic Steel Co.) has been installed in west Texas to carry fuel to 200 irrigation pumps. It is believed to be the longest of its kind in the country.

A new extrusion plant in Lubbock, Texas (United Pipe & Tube Co.), will extrude rigid polyvinyl chloride and styrene-butadiene-acrylonitrile pipe for use in oil fields and industrial plants, for water systems and gas distribution. Pipe sizes up to 12-in. dia. will be produced. Long-range plans include production of plastic-lined steel pipe.

Polyvinyl chloride can be blended with thermoplastic copolymers (*Cycolac* series, Marbon Chemical) containing acrylonitrile, butadiene, and styrene, to produce improved processing, increased heat resistance, and increased impact strength. Room temperature impact values exceeding 10 or 15 ft.-lb. are possible for blends containing approximately 50 parts of blending resin copolymer.

Polystyrene has come a long way since its commercial introduction in 1935. It was undoubtedly the wide consumer acceptance of this thermoplastic, despite its inherent deficiencies, which contributed greatly to the development of a unique series of hybrid thermoplastics that today are designated by the term "styrene alloys." To broaden the market for styrene-based resins, the drawbacks of brittleness and low heat distortion temperature had to be overcome.

Between 1944 and 1946 three resins that exhibited an improvement in heat distortion temperature over general-purpose polystyrene were commercially introduced. Polydichlorostyrene and the copolymers, styrene fumaronitrile and styrene divinylbenzene, ranged between 220 and 250° F. in heat distortion temperatures. But cost, poor moldability, and continued technical advances in the field of copolymers limited commercial acceptance of these resins.

In 1946 acrylonitrile was copolymerized with styrene and the copolymer met with wide industry acceptance. The advantages of this copolymer over polystyrene were its higher heat distortion temperature, somewhat improved impact strength, excellent weathering resistance, better chemical resistance, and higher flexural strength at elevated temperatures. Izod notched impact strengths were still under 1 ft.-lb./in. of notch, and it was recognized that greater improvements would be necessary.

Styrene and rubber

By 1948, a basically new principle in polymer chemistry demonstrated that suitable blends of the right resin and rubber would exhibit the hardness and high heat distortion of the resin and the toughness and low brittle point of the rubber.

Copolymerization of styrene with small amounts of butadiene produces tough, horny resins which the rubber industry has blended with GR-S type rubbers as reinforcing agents and processing aids. This development bordered on the plastics industry; when the resin ratio was high enough (over 60%), the blend assumed more the properties of a plastic than of an elastomer. Uncured, the high resin blends were limited in application because of low flexural strength and low heat distortion point. When vulcanized by usual rubber procedures, however, the composition forms a tough, rigid thermoset material. The softening point of typical cured blends was still between 130 and 140° F.

A second type rubber-resin blend commercialized in 1946 in the form of fabricated parts or sheet stock constituted a major advance in the field of high-impact materials. The discovery that styrene acrylonitrile copolymer resins could be blended with

* Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Recent Developments and References were prepared by the editors.

butadiene acrylonitrile rubbers made available a new series of styrene alloys possessing greater impact strength, higher heat distortion temperatures, improved chemical resistance, better weathering qualities, and good flexural strength. These materials are commonly known as acrylonitrile - butadiene - styrene polymer blends (ABS polymer blends).

Between 1949 and 1955 more than 15 styrene alloys were introduced commercially. These were based on blends of polystyrene and/or styrene-butadiene copolymers of varying ratios. When alloyed with high-styrene low-butadiene copolymers, polystyrene yields high impact, high flexural strength thermoplastics. A number of variations of this alloy are possible since two ratios exist—styrene to butadiene and polystyrene to styrene-butadiene copolymer.

Property variations depend largely on the resin/rubber ratio. In addition to high impact strength and flexural strength, this type of styrene alloy may possess greater ultimate elongation and lower brittle point than polystyrene. Due to the internal plasticizing effect of the butadiene, it is handicapped by softening points lower than those of polystyrene. Low cost, good moldability, and medium-to-high impact strengths have, however, resulted in widespread commercial acceptance.

A new series of molding powders offered commercially in 1949, based on a copolymer blend of styrene-acrylonitrile and butadiene-acrylonitrile, was similar in properties to the blends introduced earlier in the form of fabricated parts or sheet stock. A wide range of physical and chemical properties was possible by adjusting the proportion of styrene to acrylonitrile in the resins and of butadiene to acrylonitrile in the rubber, as well as by varying the ratio of resin-to-rubber in the final alloy blend. Selected numbers of this series of alloys have been made commercially available.

Another combination of butadiene, styrene, and acrylonitrile reported by the manufacturer to be a "homogeneous" composition was introduced in late 1953. It combines high hardness with impact over a wide temperature range, good processing qualities, high heat resistance, and excellent chemical resistance.

Chemistry and manufacture

Styrene monomer is generally produced by catalytic dehydrogenation of ethylbenzene which is obtained by reaction of benzene with ethylene. Styrene is also produced by the reaction of benzene with acetylene.

Polymerization of styrene, or copolymerization with a variety of other monomers including butadiene and acrylonitrile may be accomplished by bulk, suspension, emulsion, and solution polymerization techniques.

Recent developments in techniques such as series, graft, and block polymerization are regarded as major advances in the art. Styrene alloys produced by use of these techniques reportedly offer greater ease in processibility and relatively high impact strengths at low temperatures (—40° F.).

In the production of styrene alloys, latex blending and Banbury-mill mixing are used with equal success. Latex blending, as the name implies, involves the blending of polymer or copolymer latices. Coflocculation of the latices by the addition of sulfuric, lactic, or formic acid or other flocculating agents results in a resinous crumb which is filtered and washed to remove soluble residue. When dried, this masterbatch may be compounded with other ingredients by Banbury, mill, extruder, or other mixers.

Injection molding

The styrene alloys are well suited to injection molding, and can be readily handled on standard machines. Most manufacturers recommend predrying granules at 160 to 200° F. for a period ranging from 45 to 90 min. or longer. The use of hopper driers or preplasticators is frequently recommended. Predrying and preheating eliminate the possibility of absorbed water affecting the molding surface, increase capacity since they permit the injection heating cylinder to heat a greater volume of material per hour, and improve quality by permitting the use of lower but more uniform material temperatures.

Cycle, temperature, and pressure used in molding styrene alloys depend on the pieces being molded, the specific alloy being used, the geometry of the die, and the machine itself. Styrene alloys are readily adapted to both heavy and thin section moldings.

Materials manufacturers recommend cylinder temperatures in the range of 300 to 550° F., die temperatures in the range from 130 to 200° F. Some manufacturers recommend the use of nozzle heaters to insure maximum alloy flow properties in the die.

Extrusion and calendering

Styrene alloys may be handled easily in standard extrusion equipment to produce pipe, tubes, rods, and profiles. The rubber content of most styrene alloys is such that in extrusion it does not approach the near-Newtonian flow characteristics of some thermoplastics.

Predrying is generally recommended. Cylinder and die temperatures vary depending on the rubber content of the blends, but roughly they range between 390 and 450° F. Clearance between the screw and cylinder wall should be small, ranging between 0.003 and 0.005 inch.

Most manufacturers report best results when a torpedo head screw, Dulmage mixing screw, or nylon metering screw is employed. A compression ratio of 3:1 to 6:1 is recommended for maximum heating and mixing results. Screen packs are used with most alloys, usually two No. 40 or No. 60 with one No. 20, to promote a degree of back pressure and greater mixing. Streamlined die lands are recommended, ranging in length from the O.D. of the extruded shape to four times the O.D. or largest cross-section.

Cooling equipment and capstans of the conventional types may be employed. Draw-down recommendations vary with different alloys and also with type of sizing equipment. Some sys-

tems require die dimensions close to that of the extruded part; others use die dimensions 10 to 15% oversize.

Extrusion of sheeting is readily accomplished with certain alloys. Flat sheeting dies are most common for styrene alloys. Cylinder temperature recommendations range from 350 to 425° F., and flat die temperatures recommended are slightly lower depending on the alloy. Biaxial stretching by the use of clamps at the die opening has been found to improve physical properties of extruded sheets. Most styrene alloys are rigid or semirigid on cooling, and are cut in desired lengths for finishing.

Certain of the more resinous alloys may readily be calendered into sheeting 0.015 to 0.090 in. thick with excellent results. It is recommended that the alloy be worked on a mill at temperatures between 300 to 400° F., and fed in small slugs to the calender. On four-roll calenders, of the Z or inverted L types, forming roll temperatures usually range between 280 and 380° F. with the bottom roll slightly cooler. Sharp reproduction of detail is reported with certain of the alloys when an engraved calender roll is employed. Embossing may also be accomplished by setting embossing rolls next to the bottom calender roll.

Properties and applications

The variety of styrene alloys commercially available offers the plastics fabricator a wide range of properties. Some of the more important properties of commercially-available styrene alloys are outstanding impact strength, ranging up to 11 ft.-lb./in. of notch; high heat distortion temperatures, ranging up to 210° F.; a range of hardnesses, Rockwell R50 to R110; low brittle point of −40 to −60° F.; excellent chemical resistance; good mechanical properties; and good molding and extrusion characteristics. See Table I, below.

Injection molders have recognized that the higher unit cost of some of the alloys is more than offset by their unique toughness and high heat distortion temperatures. Appearance of the finished molded articles is excellent, and a range of colors is available.

Continued development of injection press preplasticators and larger machines with greater injection speeds will increase the number of functional and decorative applications for which the styrene alloys are used. Some of the present outstanding applications for injection molded alloys are in pipe fittings, wheels, helmets, valve parts, golf club heads, refrigerator parts, bobbins, radio cabinets, electric fan blades, toys, battery cases, and appliances.

Extruded acrylonitrile copolymer blend pipe, mainly because of its unique toughness and corrosion resistance, has substantially advanced the position of plastic pipe in a number of important applications. This pipe is widely used by the petroleum industry where piping is subject to extraordinary corrosion by brine and sour crudes, as well as in natural gas pipe lines, mine drainage systems, and irrigation applications. Paper mills, sewage disposal plants, water treating plants, heavy and fine chemical plants, textile plants, and food handling plants have all reported lower maintenance and replacement costs after installing these versatile piping materials.

Styrene alloy sheeting, extruded or calendered, is available in a wide assortment of colors and finishes. The rigidity and inherent toughness of this type of sheeting has led to its use in such outstanding applications as industrial duct work, automobile headliners and kick plates, typewriter cases, refrigerator door liners, tote boxes, trays, and a variety of functional and/or decorative housings.

References

Consult the Subject Index for additional information on styrene alloys. See also the Plastics Properties Chart for information on properties and trade designations. For sources of styrene alloys, see Directory Index, p. 1018.

"Reverse - printed overlays," MODERN PLASTICS *34*, 97 (Sept. 1956).

"Styrene cases for better batteries," MODERN PLASTICS *33*, 186 (June 1956).

"Portable coin sorter," MODERN PLASTICS *33*, 183 (June 1956).

"Trapped-sheet forming," by E. T. Aldington, P. S. Rath, and A. M. Tobia, MODERN PLASTICS *33*, 117 (Mar. 1956).

"Butadiene-styrene copolymers for shoe soles," Brit. Plastics *29*, 387 (Oct. 1956).

"Toughened polystyrenes," by V. H. Wentworth, Brit. Plastics *28*, 507 (Dec. 1955).

"Kralastics," by E. J. Trunk, Product Eng. *26*, 171 (Nov. 1955).

TABLE I: Comparison of properties of polystyrene and styrene alloys

Properties	*Polystyrene*	*Styrene acrylonitrile copolymer*	*Modified styrene*		*Acrylonitrile copolymer blends*
			Med. and high impact	*Very high impact*	
Specific gravity	1.04-1.07	1.07-1.10	1.05-1.11	0.98-1.10	1.01-1.10
Tensile strength, p.s.i.	5000-9000	9500-12000	7000-12000	3500-6500	3000-6000
Elongation, %	1.0-3.6	1.5-2.5	1.5-2.5	10-90	20-50
Flexural strength, p.s.i.	8000-16000	13000-17000	10000-17000	5000-7000	4500-11500
Izod impact strength, ft.-lb./in. of notch	0.25-0.5	0.35-0.5	0.25-0.5	0.5-10	0.4-12
Heat distortion temp., ° F.	160-190	195-215	160-190	150-190	170-195
Hardness (Rockwell)	R120	R125	R120	R50-R110	R60-R110
Molding qualities	Excellent	Good	Excellent	Very Good	Good

Synthetic Rubber and Rubber Derivatives

BY L. H. HOWLAND* and R. W. BROWN*

RECENT DEVELOPMENTS

An **improved tarpaulin material** (*Fairprene*, Du Pont Fabrics Div.) provides greatly increased abrasion resistance combined with lightness. The new tarpaulin consists of nylon fabric with an exterior coating of neoprene (Du Pont) and a coating of synthetic rubber (*Hypalon*) on the underside.

New resins for rubber reinforcing (*Cellobond*, British Resin Products, Ltd.) are readily dispersible with natural and nitrile rubbers at all loadings. Due to their initial thermoplastic nature, these cashew phenolic-type resins facilitate the processing of highly loaded stocks, at the same time reinforcing hardness and other physical characteristics.

An epoxy rubber compound (*Maraset No. 636*, Marblette Corp.) is used as a gasket and sealing compound as well as an encapsulating resin for electronic compounds. This material has a tensile strength of 2600 p.s.i., an elongation in percent of 200, a durometer (Shore A) of 50-60, and is said to have excellent recovery.

A series of vinyl-silicone rubber compounds (*K-1044R, K-1045R, K-1046R, K-1047R, K-1048R*, Silicones Div., Union Carbide & Carbon Corp.) meets the toughest aeronautical specifications for high-temperature applications. These rubbers have controlled reactivity, high tear, high elongation, tensile strength of over 800 p.s.i., low compression set, good oil resistance, low moisture absorption, and good dielectric properties. They are "preconditioned" to permit easy processing.

Butadiene-styrene (formerly GR-S) copolymers are the largest volume products among the synthetic rubbers. They comprise a varied group of solid polymers and latices ranging all the way from 100% polybutadiene to copolymers containing up to 50% bound styrene. Masterbatches are available containing oil, carbon black, or mixtures of the two, and latices are manufactured at solids contents ranging from about 25 to 60 percent. The most widely used polymers contain approximately 75% butadiene and 25% styrene. Lower levels of styrene give better low-temperature flexibility at some sacrifice in physical properties, while higher levels of styrene give more plastic and less rubbery copolymers. Above about 60% styrene content, resinous products, rather than elastomers, are obtained.

The GR-S polymers used during the war were produced by what is termed "hot" polymerization. It was later found that polymerization at lower temperatures gives appreciably better properties, particularly with respect to tensile strength, abrasion resistance, and flex cracking. As a result, recipes were developed to permit rapid polymerization at the lower temperatures and, today, about 80% is made by the "cold" process.

"Cold" rubber is prepared commercially at about 41° F., although experimental runs have been made at temperatures of 0° F. and below. It is made by emulsifying the butadiene and styrene in water with fatty acid or rosin soap and polymerizing in pressure vessels with agitation to form a stable water dispersion of the polymer (latex). An organic hydroperoxide is used as catalyst along with various activators which speed up the rate of polymerization. Long chain (C_{12}-C_{16}) mercaptans are used as chain transfer agents or modifiers to give the desired plasticity. These recipes readily give reaction times of 6 to 12 hr. at 41° F. Cold GR-S is normally carried to 60% conversion. The hot polymers are prepared in a similar manner, except that the reaction temperature is 122° F., and potassium persulfate is the catalyst. The reaction is stopped at about 72% conversion.

Unreacted monomers are removed by vaporization and recovered for future use. The latex is then coagulated by treatment with acid or alum to destroy the soap, along with other chemicals (salt, glue, etc.) to control the size of the lumps of coagulum. The coagulum is then washed, dried, and baled. Careful control of variables in production makes synthetic rubber of considerably greater uniformity than natural rubber.

Some polymers are produced with lower than normal amounts of mercaptan modifier to give tougher rubber, which is then mixed with an amount of low-cost petroleum oil (usually 25 to 40%) in sufficient quantities to soften the rubber-oil mixture to a normal plasticity. The product has the usual handling and vulcanizate properties of synthetic rubber but is considerably reduced in cost. Mixing of the oil is done while the rubber is still in the latex stage to avoid handling of the tough unplasticized polymer. In 1956 these oil masterbatches had grown to about 40% of the total production of butadiene-styrene rubber.

The butadiene-styrene polymers as a group are general-purpose rubbers of wide applicability. They are used in tires, mechanical goods, footwear, and al-

* Synthetic Rubber Plant, Naugatuck Chemical, Div., United States Rubber Co., 203 Elm St., Naugatuck, Conn.

Recent Developments and References were prepared by the editors.

most all of the other places where natural rubber is satisfactory. One exception is in the carcasses of large truck tires, where their greater heat build-up during flexing makes the butadiene-styrene rubbers unsatisfactory. In the form of latex they are used for foamed sponge manufacture, rug backing, paper impregnation, and other applications. They have good aging qualities and are tough and resistant to heat and abrasion. Tire treads made from cold rubber show an increase in abrasion resistance of 15 to 25%, as compared to natural rubber.

As a class, the copolymers of this group develop much lower cured gum properties than natural rubber. Cured gum stocks of natural rubber range around 3500 p.s.i. whereas the GR-S polymers will fall far short of this range, showing less than 1000 p.s.i. However, by compounding properly with reinforcing pigments, resins, and plasticizers, stocks can be developed with tensile strengths almost comparable to those of natural rubber. On an over-all basis, the processing of GR-S can be controlled to a point at which special features can be "built into" the polymer so that processing is more adaptable and consistent than with natural rubber.

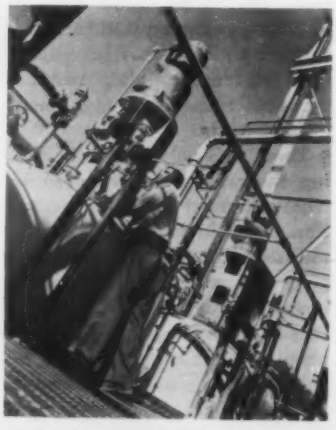
Butadiene-acrylonitrile copolymers

The butadiene-acrylonitrile copolymers (nitrile rubbers) are the same in general appearance and processing qualities as the butadiene-styrene copolymers. They contain various proportions of butadiene and acrylonitrile ranging from approximately 80/20 to 55/45. Manufacture is similar to the butadiene-styrene types, with a strong trend toward low-temperature polymerization. Their vulcanizates are characterized chiefly by high resistance to the swelling action of solvents, oils, and greases, and to deterioration by heat and sunlight. They are soluble in ketones such as acetone. These copolymers are also available as latices, which are useful for the impregnation and coating of many types of cloth, paper, and leather products.

The nitrile rubbers are cured with the same agents as natural rubber or GR-S, i.e., sulfur or sulfur-bearing materials. Again, as is the case with GR-S, the cured gum tensile strengths of nitriles are far below that of natural rubber, but with proper choice of compounding ingredients tensile strengths as high as 4000 p.s.i. can be obtained. One major change in the compounding of nitrile rubbers must be noted. Because of the oil-resistant nature of the basic polymer, many of the normal rubber plasticizers are ineffective. The ester-type oils and polar-type derivatives are the most effective.

Generally speaking, the same procedures can be employed when processing nitrile rubbers as are used with natural or styrene-type rubbers. However, the nitrile polymers require more critical milling and Banbury procedures. Ultimate dispersion of reinforcing pigments and curatives is more difficult. Building tack in these polymers is more of a problem than with the styrene polymers. In some cases, solvent activation of the rubber surface with a ketone solvent is necessary before it is possible to obtain building tack.

The chief advantage of the nitrile-type synthetic elastomers is their high resistance to the deteriorating and swelling effects of greases, oils, waxes, and solvents. Coupled with this advantage, the nitrile polymers can be compounded to be flexible at temperatures below —70° F. and to resist the deteriorating effects of high-temperature aging up to 300° F. The choice of the nitrile content is directly affected by the degree of oil resistance desired, and this increases as the nitrile content increases. However, as the nitrile content is raised, the copolymer loses in low-temperature characteristics.



Basic polymerization step in manufacture of synthetic rubber takes place in reactor vessel. (Photo, U. S. Rubber)

Some phenolic and vinyl resins, such as polyvinyl chloride, harden the nitrile rubbers, allowing a reduction in amount of mineral fillers. These resins also give compounds that are more resistant to the effect of solvents, high temperatures, and oxidation, and in some cases more fire-resistant. On the other hand, the addition of the nitrile rubbers to compounds containing predominant amounts of phenolics gives improved processing, impact resistance, and flexibility. In predominately polyvinyl chloride and related vinyl compounds, they act as nonvolatile, nonextractable plasticizers. Added to phenolic-resin cements the nitrile rubbers impart flexibility to the adhesive film, particularly at low temperatures.

Isobutylene-diolefin rubber

Butyl rubber is a copolymer of about 98 parts of isobutylene and 2 parts of isoprene. It differs from its nearest chemical neighbor, polyisobutylene (Vistanex), by being vulcanizable, a property imparted to it by the unsaturation of the copolymerized isoprene. This unsaturation, however, amounts to only about 3% of that normally occurring in natural rubber. This low degree of unsaturation is the major reason for the chemical inertness of butyl, upon which many of its uses depend.

Butyl rubber is prepared at very low temperatures (about —140° F.) by treatment of a solution of the monomers in methyl chloride with anhydrous aluminum chloride. The polymer forms as a slurry in the methyl chloride, from which it is recovered by treatment with hot water to vaporize the solvent and unreacted monomers.

Crude butyl resembles natural

rubber in appearance and handling properties. It is tacky, and tends to flow under its own weight. It is compounded and processed in the same manner and with the same machinery as is natural rubber or GR-S. With butyl, no breakdown or premastication is needed and its natural tackiness gives it excellent building characteristics. Softeners may be added to improve processing or special properties like resiliency or flexibility at low temperatures. Butyl is highly impermeable to gases. As a result, it has almost completely displaced natural rubber for inner-tube manufacture.

Aging- and temperature-resistance properties make butyl useful for fabricating curing bags which are employed in the vulcanization of tire casings and for the repairing of tires. Its good electrical properties coupled with its resistance to ozone make it well-suited for all grades of insulation. Furthermore, it has remarkable resistance to the chemical action of concentrated sulfuric, hydrochloric, hydrofluoric, and phosphoric acids, ferric chloride, caustic, and other corrosive substances. It finds special use as linings in tanks, pumps, and hoses.

Because of the low degree of unsaturation, butyl stocks are difficult to cure as compared with the diene polymers. It also cannot be used in blends without severe vulcanization problems. Resilience is markedly lower than that of natural rubber. The polymer crystallizes on stretching, and excellent gum tensiles are obtained, approximately 3000 p.s.i. Butyl is similar to natural rubber and neoprene in this respect. The addition of fillers such as carbon blacks will definitely improve many of the physical characteristics such as tear resistance, abrasion, and toughness.

Care must be taken in the choice of plasticizers. Should there be any unsaturation present, as there is in some aliphatic plasticizers, the cure of the compound will be seriously retarded.



Synthetic rubber is put through a tuber machine that squeezes large chunks into smaller pieces and removes water from the rubber. (Photo, U. S. Rubber)

Neoprene rubber

Neoprene is a generic term denoting synthetic rubbers made by emulsion polymerization of 2-chloro-1,3-butadiene, or copolymers containing predominant amounts of this monomer. It is prepared similarly to other emulsion polymers. The polymer is isolated from the latex by a unique process of freeze coagulation on cold rolls, washed, and dried. Several types of crude neoprenes are produced, differing in unvulcanized properties that are important in the processing operations in the manufacture of finished products. Several types of neoprene latex are also available.

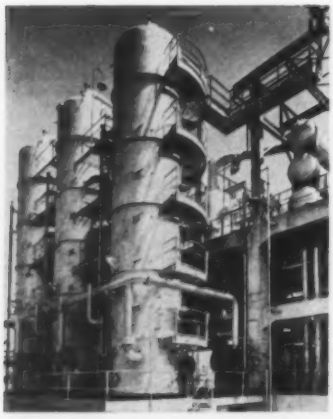
Compounding with various ingredients and further processing are carried out as with natural rubber, using regular rubber-processing equipment. Unlike natural rubber and many synthetic rubbers, neoprene is vulcanized with basic oxides (e.g., MgO); sulfur is not necessary in the majority of neoprene compounds. Room-temperature curing compounds have been developed for protection of equipment against abrasion and corrosion.

The tensile strength, elasticity, resilience, and abrasion resistance of neoprene vulcanizates are similar to those of natural rubber stocks. However, its resistance to ozone, sunlight, and chemicals is far better. Exposure to oil causes slight swelling of neoprene stocks, but even in the swollen condition they retain a high proportion of their original characteristics. In applications that require a seal against oil or gas, this slight swelling increases the sealing pressure of the gasket or seal.

Specialty polymers

Polyacrylic ester rubbers: Although the esters of acrylic acids are usually considered as plastics (e.g., polymethyl methacrylate), elastomeric polymers of this type are also available. These polyacrylic rubbers can be cured to give products highly resistant to discoloration, ozone, gas diffusion, and many oils at temperatures up to 350° F. They are not resistant to steam, glycols, or aromatic solvents, nor are they recommended for low-temperature service. Due to their saturated nature, they require special vulcanizing agents, of which polyfunctional amines are the most common. Latices containing elastomeric polymers of acrylate esters are also available and have recently come into considerable use, particularly in protective coatings.

Organic polysulfides: Reactions of organic dihalides and alkali polysulfides yield condensation



Styrene stripping columns. Function of towers is to remove unreacted styrene monomer from latex before coagulation, if final product is to be dry rubber. (Photo, Goodyear)

polymers that vary from viscous liquids to rubberlike products. These polysulfide polymers are also produced in the form of water dispersions.

The polysulfide rubbers are processed and handled like natural rubber. Curing is carried out with metallic oxides (usually zinc oxide). Tensile strength and abrasion resistance are low compared to some of the other synthetic rubbers but are adequate for many purposes. Resistance to aging, ozone, and sunlight are excellent. Permeability to gases is low, and electrical insulation properties are good. The property that makes organic polysulfide rubbers of particular interest is their high solvent resistance. They are serviceable in most aliphatic and aromatic hydrocarbons as well as the common alcohols, ketones, and esters. Protective coatings that give good protection against fresh and salt water, as well as solvent resistance, are based on these polymers. Major uses include hose, printing rollers, permanent putties, gaskets, and binders for various fibrous materials.

Silicone rubbers: Silicone rubbers are a unique group of polymers in which silicon-oxygen linkage has replaced the usual carbon-carbon linkages in the backbone of the polymer chain. The silicone is supplied as a gum which is processed on standard rubber equipment. It is mixed with suitable fillers and cured at high temperatures. Curing is normally carried out by means of peroxidic agents, e.g., benzoyl peroxide. The outstanding properties of the silicones are extreme resistance to temperature changes; they remain flexible over a temperature range of —100 to 500° F. and may be used up to 600° F. in some cases. They are also unaffected by ozone and are highly resistant to hot oils. Electrical properties are excellent. The tensile strength of the polymer is low, and it is attacked by steam, acids, strong alkalies, and some solvents. Very finely divided aluminas and silicas give considerable improvement in tensile strength. Silicone rubbers have found extensive use in wire insulation, tubing, packing, and gaskets, particularly where extreme heat resistance is needed. Dispersions and pastes are also available, and are used for dip coating, spraying, brushing, and spreading.

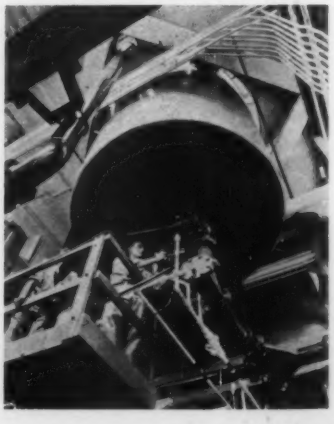
Polyurethane rubbers: The polyurethane rubbers are elastomeric materials prepared by reacting a polyester or a polyether containing terminal hydroxyl groups with a diisocyanate (e.g., toluene diisocyanate) and so-called "cross-linking" chemicals. Alternatively, the hydroxyl compounds may be treated with a deficiency of diisocyanate to give materials with terminal isocyanate groups which can still be worked, and the final curing carried out with polyfunctional agents such as water, glycols, diamines, and amino-alcohols. When water is used as a cross-linking agent, carbon dioxide is evolved. Therefore, the material must be worked to allow the gas to escape before press curing. The final products from the polymers are characterized by high tensile and tear strengths and excellent abrasion resistance without the necessity for fillers, although reinforcement with carbon black results in still better properties. The first polyurethanes were not resistant to acids or alkalies but some newer types are greatly improved in this respect. In making foams, a polyether or polyester terminated by hydroxyl groups is first reacted with an excess of diisocyanate and thereafter with water and usually a tertiary amine catalyst. Simultaneous polymerization and blowing takes place to form a foam which has high modulus and is useful in making a variety of foam sponge objects.

Fluororubbers: The chemical inertness and insolubility of fluorinated organic compounds is being exploited in the development of polymers for use under extreme conditions of heat and solvent attack. Polytrifluorochloroethylene is already well-established in this field, and other related products are coming into production. Costs are high, but the desired properties outweigh this factor in a wide variety of applications. The fluororubbers are characterized by extreme resistance to solvents and heat, good dielectric strength, and marked lack of adhesive tendencies. Useful temperature ranges extend up to 500° F. for continuous, and to 600° F. for intermittent service.

Chlorosulfonated polyethylene: Another somewhat recent synthetic rubber, Hypalon, is chlorosulfonated polyethylene. It can be compounded with suitable ingredients and the resultant mixes may be used to produce extruded, calendered, or molded products. Also, solutions in solvents may be used for protective coatings.

"Synthetic natural rubber": The new processes devised to synthe-

Discharge lines of polymerization vessel lead to flash tank for removal of unreacted butadiene. (Photo, Goodyear)



size natural rubber are an important progressive step. These rubbers have been checked in all aspects against natural rubber and according to all available reports little or no difference can be found between these synthetic materials and natural rubber. It is known that quite different catalytic systems are used to produce very similar end results. Basically, the reaction is the polymerization of the monomer to cis-1,4-polyisoprene which has a minimum of trans-1,4-polyisoprene. This, in effect, produces a polymer of uniform structure and contributes to the effect of crystallization which in turn aids in obtaining the high gum tensiles and other qualities of natural rubber. Indications are that these new elastomers cannot be produced with the present synthetic rubber type equipment and that new installations as well as procedures will have to be developed before large quantities will be available.



Collapsible fabric containers with synthetic rubber coatings are used in Arctic region to carry fuel for military use. (Photo, U. S. Rubber)

Rubber derivatives

A considerable variety of derivatives, mostly of a resinous nature, are prepared from rubber by treatment with chemical agents. Natural rubber is used primarily as the raw material. Although all of the reactions have been carried out with synthetic rubber (usually butadiene-styrene types), reaction conditions are more drastic, and the products have not reached large-scale production. However, resinous products prepared directly from the monomers used in synthetic rubber production (primarily butadiene-styrene copolymers containing high levels of styrene) have reached very large-scale production and have to a certain extent replaced natural rubber.

Cyclized rubber: Treatment of natural rubber with strongly acidic reagents (sulfuric or sulfonic acids, stannic chloride, etc). causes a rearrangement of the molecules with the formation of cyclic structures. About one-half of the original unsaturation is lost. The resulting products are hard, resinous, and thermoplastic rather than rubbery. They are supplied as powders or granules. They have good solubility and produce flexible films having excellent chemical resistance and low water-vapor penetration. Adhesives based on these products give very strong metal-to-rubber bonds. Major uses are as stiffening agents in natural and synthetic rubber vulcanizates, in paper coatings, as adhesives, in printing inks, and in hot-melt coatings.

Chlorinated rubber: Chlorine both adds and substitutes in the rubber molecule. Products containing 65 to 70% chlorine are produced as thermoplastic resins. They are resistant to the action of moisture, oils, and many corrosive chemicals. Solutions in chlorinated solvents are used for paints and lacquers. Films of low permeability to water can be prepared. Chlorinated rubber is odorless, tasteless, nontoxic, and nonflammable.

Rubber hydrochloride: Hydrogen chloride adds to natural rubber to give a thermoplastic product containing about 30% chlorine. It is produced as film in a variety of thicknesses by solvent-casting techniques. Strength of the film is greatly increased by tensilizing (stretching in two directions). Rubber hydrochloride is used primarily for packaging and in wearing apparel.

Depolymerized rubber: Natural rubber can be depolymerized to such an extent that it is a liquid at normal temperatures. This material is used as a plasticizer for resins, rubber, and the like. It can also be cured by conventional agents and is used as a potting compound, particularly for cable connectors. Liquid synthetic rubbers, particularly polybutadiene and nitrile types, are also available. They are made by direct polymerization to the desired low molecular weight.

References

Consult the Subject Index for additional information concerning synthetic rubber and rubber derivatives. See also the Adhesives, Coatings, Foamed Plastics, and Plastics Properties Charts for information on properties and trade designations. For sources of these materials, see Directory Index, p. 1018.

"Compounding acrylate polymers for resistance to a diester lubricant," by W. J. Mueller and R. A. Clark, Ind. Eng. Chem. *48*, 982 (June 1956).

"Dilaminar elastomeric films," by M. G. Defries, L. Schneider, P. Fram, and F. Leonard, J. Polymer Sci. *20*, 267 (May 1956).

"Rubber-modified alkyd sealers for castings," Materials and Methods *43*, 130 (Apr. 1956).

"Coral rubber—a cis-1,4-polyisoprene," by F. W. Stavely and co-workers, Ind. Eng. Chem. *48*, 778 (Apr. 1956).

"Ameripol SN—a cis-1,4-polyisoprene," by S. E. Horne, Jr., J. P. Kiehl, J. J. Shipman, V. L. Folt, C. F. Gibbs, E. B. Newton, M. S. Reinhart, and E. A. Willson, Ind. Eng. Chem. *48*, 784 (Apr. 1956).

Vinyl Polymers and Copolymers

BY B. BAUM*

Although the existence of vinyl resins was known for more than 50 years, it was not until the early 1930's that vinyl polymers and copolymers gained commercial importance. Manufacturers then began to realize that vinyl resins were bringing forth materials which, in their versatility and breadth of application, were unlike anything heretofore developed. Commercial exploitation of vinyls was made possible largely by the incorporation of a plasticizer into the resin formulation. These plasticizers, which are a special class of resin solvents distinguished from ordinary solvents by their low volatility, enable a rigid plastic material to become flexible and therefore useful for many varied applications. In addition, before these versatile vinyl resins could actually be used to advantage commercially, the problem of resin degradation from heat and light had to be resolved. Available today are numerous excellent stabilizers such as salts of cadmium, lead, tin, and barium. These materials protect the resins during processing as well as in their many end applications. The continued development of new resins, plasticizers, stabilizers, and other compounding ingredients offers great future promise for the vinyl industry.

* Development Laboratories, Bakelite Co., Div. of Union Carbide Corp., Bound Brook, N. J.
Recent Developments and References were prepared by the editors.

Methods of polymerization

Suspension polymerization: Commercially, the suspension system is the most widely-used method of polymerization; it is applicable to both the polymers and copolymers of vinyl chloride. Suspension polymerization employs a water medium, the water being dispersed in droplet size by a dispersing agent. The catalyst is usually an organic peroxide soluble in the monomer phase. The polymer is filtered from the water suspension in the form of hard, dense particles.

Solution polymerization: In this system, both the monomer and catalyst are dissolved in a suitable solvent. Polymerization takes place in an autoclave at a somewhat elevated temperature. The polymer is usually precipitated from solution, dried, and sold as a finely-divided powder. Due to the poor solubility of polyvinyl chloride, this method is generally used only for copolymers.

Bulk polymerization: In this

RECENT DEVELOPMENTS

Drum liners for hot-melt and tacky materials (Food Film, Inc.), made of polyvinyl alcohol, can handle adhesive and cohesive materials which normally are very difficult to remove from the drum. The liners are preferably placed by air pressure. Molten materials at temperatures up to 400° F. can be poured into them.

Three-dimensional fabrics (*Lum-Puf*, Lumite Div., Chicopee Mills, Inc.), for use in automobile upholstery, seat covers, and outdoor and office furniture, are produced by weaving high-shrinkage saran with normal saran and exposing the fabric to controlled dry heat. The differential shrinkage produces sharply accentuated puffs in the fabric.

A special-purpose viscosity stabilizer (*VS-1*, Camros Chemical Co.) can be used to maintain the original viscosity characteristics of vinyl chloride plastisols over extended periods. Three to 5 parts per hundred parts of resin provide effective stabilization.

A new textile fiber (*Darlan*, B. F. Goodrich Chemical Co.) based on vinylidene dinitrile is extremely soft, resilient, stable, moderately strong, and durable, according to the manufacturer.

A gold ink for printing on vinyl provides good tarnish and greening resistance. (Claremont Pigment Dispersion Corp.)

A vinyl-coated Fortisan awning fabric (*Herculite Awning*, Herculite Protective Fabrics, Inc.), competitively priced with canvas, retains perfect fit under temperature extremes. This fabric is lightweight, durable, and nonflammable. Electronically-welded seams are said to prevent seam failures.

Flexible vinyl film (*Koroseal*, B. F. Goodrich Industrial Products Co.), used as a vapor barrier between roof deck and insulation, prevents drippage of flammable asphalt or tar which can add to the seriousness of industrial fires. The roof vapor-barrier construction (Lexsuco, Inc.) has been proved by Factory Mutual tests as fire retardant with a Class 1 rating.

Cold-reduced steel sheets coated with vinyl (U.S. Steel Co.) promise new decorative effects and long service in such equipment as refrigerators, radio and TV cabinets, wall panels, automotive bodies, stove and heater parts, railroad coach, club, and sleeping car interiors, and office and home furniture.

A clear primer (*69X-1406*, The Stanley Chemical Co.) provides good plastisol adhesion to metal. Effective whether baked or air-dried, it is transparent and colorless and recommended for use

system, the only materials present in the autoclave during polymerization are the monomer and peroxide catalyst. As it forms, the polymer is insoluble in its own monomer; it is then separated in a fluffy form from the monomer by filtering or centrifuging. Bulk, as well as suspension and solution polymerization, gives resins that are free from ionic impurities and therefore useful for electrical applications. Resins polymerized by the bulk method readily absorb plasticizers.

Emulsion polymerization: Vinyl polymers can be polymerized in an aqueous medium containing an emulsifier and a water-soluble initiator. A typical "recipe" would consist of the following ingredients:

Additives	*Parts by weight*
Monomer	100
Water	180
Fatty acid soap (such as sodium lauryl sulfate)	2 to 5
Potassium persulfate	0.1 to 0.5

This technique results in a colloidal suspension of the polymer in water. Emulsion polymerization is more rapid than bulk or solution polymerization, but unlike these methods, it leaves ionic ingredients in the polymer which degrade the electrical properties.

POLYVINYL CHLORIDE

Polyvinyl chloride is a hard, tough, transparent, thermoplastic resin characterized by high inherent strength. One of its outstanding properties is that it can be plasticized to a high degree of flexibility and still maintain appreciable strength. Vinyl chloride resins have exceptional resistance to many chemicals such as acids, alkalies, alcohols, and aliphatic hydrocarbons. In addition, they are resistant to oxidation and are self-extinguishing. These properties are dependent, to a certain extent, upon the modifying ingredients that may be added. Plasticizers, stabilizers, fillers, and pigments may all contribute to a significant change in the properties of the end product. The incorporation of heat stabilizers is required for the commercial use of polyvinyl chloride resins. For outdoor applications, light stabilizers also have to be incorporated. The most important types of polyvinyl chloride resins now being produced are general-purpose, paste-type, and water-dispersed.

General-purpose resins are granular white powders with particle diameters in the range of 0.0025 to 0.0060 inch. They are either round, marble-like spheres, or porous, spongy particles designed to absorb plasticizers faster during processing. The specific gravity of the resin is approximately 1.4, and compound gravities range from 1.24 to 1.7, depending upon type and properties of ingredients. Tensile strength ranges from 1400 p.s.i. in highly plasticized compounds, to 9000 p.s.i. in unplasticized compounds.

Like the general-purpose type, *paste-type resins* are white powders high in molecular weight, but their particle size is much smaller —in the range of 0.1 to 2.0 microns in diameter. These resins are used mainly in plastisol applications. When mixed with a plasticizer and fused by heating, useful end products are formed. The final properties of the compounded

---

under clear plastisol or for other applications where a colored primer would be objectionable. The primer is also available in white, for improved water resistance (*67X-832*), and yellow, for corrosion resistance (*66X-5457*).

A strippable, modified vinyl coating (*I-Sis 88,* I-Sis Chemicals, Inc.), for copper and silver hollowware and flatware, protects them against tarnishing during packaging, shipping, and handling.

Triethyleneglycol dimethacrylate (*SR-205,* Speciality Resins, Inc.) can be used as an alternative for tetra-ethylene glycol dimethacrylate for increasing stiffness and rigidity of plastisols. Among its applications are toys and gaskets.

An anionic dispersed vinyl copolymer latex (*Geon 450X3,* B. F. Goodrich Co.) shows considerable promise for expanding the use of latex paints to include exterior wood and masonry finishes, according to the manufacturer. It is internally plasticized and paint manufacturing is accordingly simplified. The excellent film-forming ability of the vinyl copolymer latex allows paint films to dry rapidly with good strength.

An organosol formulation, 35 parts plasticizer and 100 parts vinyl dispersion resin (*Pliovic AO,* Goodyear Tire and Rubber Co.), is used in decorative and protective coating applications on metal surfaces. The comparatively low plasticizer content permits production of a hard coating with less tack and greater chemical resistance than the more highly plasticized formulations.

A medium-viscosity, general-purpose polyvinyl chloride resin (*Pliovic S70,* Goodyear Tire & Rubber Co.) processes readily at temperatures that would be marginal or impossible for higher molecular weight resins. It can be used as a blending resin for "tempering" high-modulus stocks. The average particle size of this white powder material is 40 microns; the specific gravity, 1.40; and the inherent viscosity, 0.86.

A line of electrical tubings (*Transflex* and *Hyflex,* Irvington Div., Minnesota Mining & Mfg. Co.) has been modified to give fungus resistance without impairing flame resistance or clarity. The tubing is approved for both Class I and Class II (fungus resistance) in both Grade A and Grade B (general and low-temperature) as well as for Categories 1 and 2 (self-extinguishing) for both temperature grades.

A general-purpose polyvinyl chloride electrical insulating compound (*VFD-9033,* Bakelite Co.) is listed as conforming to UL requirements on 75° C. thermoplastic insulated electric blanket wire.



Extruded vinyl waterstop installed in concrete floor effectively resists water pressure. (Photo, Bakelite)

resins are similar to those of the general-purpose compounds, but because more plasticizer is used, in processing, the end products are not so hard.

Water-dispersed resins or latices are finely-divided resin particles, approximately 0.2 micron in diameter, suspended in water to about 50% total solids. The resin gravity is about 1.4, while the latex gravity averages 1.19. It can be modified by adding plasticizers as emulsions, and by using solid modifiers as dispersions.

Polyvinyl chloride resins are blended with various ingredients which make them suitable for many applications. The more important commercial forms are plasticized compounds, dispersions, plastigels, plastic alloys, and vinyl foams.

Plasticized compounds

Plasticizers are added to polyvinyl chloride resins to obtain flexibility. The end use of the compound governs the selection of a particular plasticizer. Through the use of suitable plasticizers, vinyl chloride resins can be formulated for primary electrical insulation and general-purpose wire and cable jacketing material. Such compounds provide high dielectric strength as well as toughness and chemical and moisture resistance. Constituents must be selected for the desired electrical properties. For example, aliphatic plasticizers are preferable for obtaining the best low-temperature flexibility; aromatic esters and polyesters generally impart a low degree of extractability to the end product of the compound.

Recently, there have been several developments of specialized plasticizers for specific applications. One, based on a mixture of iso- and terephthalate, rather than on ortho-phthalate ester, is designed not to mar nitrocellulose lacquer. Another new material satisfies the long-standing demand for a vinyl chloride resin that does not need an external plasticizer. The plasticizer is built into the molecule, therefore eliminating the problems involved in the loss of plasticizer by extraction or volatilization. Also available is a material that acts initially as a plasticizer and can then be polymerized *in situ* with a peroxide catalyst. This new type plasticizer results in the production of a low-viscosity plastisol, but the ultimate product is a hard, rigid material. It also allows a wider latitude in formulation.

Dispersions

There are two commercially useful types of dispersions—plastisols and organosols. Plastisols are mixtures of resins and plasticizers. Organosols contain volatile liquids as well as resin and plasticizers. Thick, tough film can be obtained from these high-solids content materials based on vinyl chloride and vinyl chloride-acetate resins. The dispersion technique has made possible a great number of useful, economical industrial coatings, formed by fusing at approximately 325 to 350° F. These coatings are heavier than those formed with copolymer resin-based solution coatings and are ideally suited for fabric, paper, and wire. The organosols may also be used as high-gloss metal finishes and dip coatings for such applications as electroplating racks and dish drainers. Plastisols can be slush molded into articles of complex shape with thin sections beyond the capability of standard molding equipment.

Plastigels

Through the addition of various metallic soaps or certain organophilic fillers, the plasticizers commonly employed in compounding vinyl chloride resin-based plastisols can be gelled. Such modified plastisols have a putty-like consistency, yet flow readily under moderate pressures. When this pressure is removed, the flow is arrested by the rapid reformation

Vinyl sheets—in both supported and unsupported form—serve as protective coverings and decorator materials in modern interior design. Living room shown below has ceiling canopy and chair upholstery of vinyl sheeting. Wall coverings are textured vinyl and floor is vinyl tile. (Photo, Vinyl Fabrics Institute)



of the gel structure. These gels retain their form up to 400° F. in some instances. Known as plastigels, these substances offer added fields of utility for vinyl chloride resins in dispersion form.

Plastigels may be extruded, calendered, molded, spread, embossed, or otherwise manipulated at room temperatures under moderate pressures such as those used for clay. This gives the plastigels the advantage of being fabricated by ordinary clay or pottery techniques. Floor tile and sheeting can be extruded, embossed, and cured in a strain-free state in the same manner as ceramic tile. Tubing and wire coatings can be extruded under low pressures in the plastigel state and cured in an oven or a hot liquid bath.

Plastic alloys

The use of physical mixtures of polyvinyl chloride and other resins is rapidly expanding. Polyvinyl chloride has been blended with styrene-acrylonitrile, butadiene-acrylonitrile, neoprene, and butadiene-vinylidene chloride to give greater impact resistance to pipe and similar products.

Vinyl foams

Foams are cellular structures formed through the expansion of a fluid material by a gas. The gas is usually evolved by the degradation of a chemical known as a blowing agent which decomposes under heat, giving off copious amounts of gas. The plastic then expands and fills the mold used. If desired, of course, the cavities of the molds can be contoured to specific shapes, e.g., toys, novelties, etc.

Depending on the production technique and formulation, the foams can be open-cell or closed-cell, flexible, or rigid. Among the advantages to be obtained with these materials are good aging properties, chemical resistance, fire resistance, and a low degree of permanent set. An additional feature is the ease with which vinyl foams can be fabricated. Presently employed fabricating techniques include cored and contour molding, molded products with integral surfacing materials, slab or sheet applications, electronically heat-sealed vinyl foam slab, and electronically heat-sealed laminated structures.



Small items being successfully dip molded of vinyl plastisol include tiny tips that cover ends of women's skirt hangers, hand grips for pliers, slip-on covers for keys, and covers for gasoline nozzles. (Photo, B. F. Goodrich)

Applications

One of the initial uses of vinyl chloride resins—electrical insulation—is an extremely large market today. Type TW, vinyl resin wire insulation, combines excellent electrical properties with fire resistance, abrasion resistance, ease of installation, and unlimited durability.

In the form of film (0.003 to 0.010 in.) and sheet (0.010 in. and thicker), vinyl chloride resins have found a practically inexhaustible market. From shower curtains and inflatables to vapor barriers and silo covers, these resins have proved their serviceability. Among the new applications for polyvinyl chloride resins

Vinyl sheeting finds major market outlet in the design of attractive home pools and pool liners. Because of their toughness, the vinyl pools can take a summer's abuse without tearing, peeling, or cracking. Pools are easily disassembled and stored away during the winter. (Photo, Bakelite)





Vinyl coatings are used on river dam because they dry quickly, resist water, and protect against corrosion. (Photo, Bakelite)

are a clear sheeting with excellent transparency for auto seat covers and a highly-polished sheeting for handbags and luggage.

One of the biggest and still-growing uses for vinyl chloride resins is in floor covering. Used most widely in resilient-type tile, these resins offer excellent abrasion resistance and the opportunity for attractive design.

Extruded products include garden hose, refrigerator gaskets, intravenous tubing, window channel seals, sliding door track, cove base for flooring, rigid pipe, and rigid channel strip for window frames.

Some of the more prominent molded plastisol products are soft items such as grommets, slush molded boots, and rotational-cast doll parts. Rigid items, such as molded pipe fittings, phonograph records, electrical plugs, press-formed rigid trays used by photographers, tote boxes, and the like, are molded by conventional methods. High resin content, low-viscosity plastisols have contributed greatly to this expansion in plastisol molding and are expected to contribute even more by making it possible to combine molding and vinyl sponge formation.

Coatings based on polyvinyl chloride resins are applied to cloth, paper, wood, and metal for use as upholstery, clothing, wall paper, and plywood veneer. A growing market for the vinyl coatings is as a protective, attractive, and warm-to-the-touch covering for business machine housings.

POLYVINYL ACETATE

Polyvinyl acetate is prepared by the polymerization of vinyl acetate in the presence of a catalyst in a manner similar to vinyl chloride polymerization. Vinyl acetate resins are characterized by the absence of color, odor, taste, and toxicity. Polyvinyl acetate is available either as a granular resin or as a dispersion in water. These resins are readily soluble in ketones, esters, aromatic hydrocarbons, and chlorinated hydrocarbons. They are insoluble in water, aliphatic hydrocarbons, glycols, higher alcohols, oils, and fats. A large portion of these resins goes into making adhesives and coatings. Properly formulated, they can be applied by brushing, molding, calendering, dipping, and roll coating. Adhesive applications of polyvinyl acetate include the bonding of cellophane, paper, cloth, mica, ceramics, metal, stone, wood, leather, glass, and cellulose ester sheets and film. Commercially, they are used as binders for metallic inks and for textile sizing.

In coating applications, latices of these resins have wide acceptance as a base for sealers, interior wall finishes, and exterior masonry coatings. Polyvinyl acetate latices have excellent pore-filling qualities, are resistant to wood gums, oil-base topcoats, acids, and alkalies, and eliminate the need for flammable solvents. These resins have proved valuable as vehicles for paints and as saturants for fibrous materials where grease resistance and tear and wet strength are among the properties required.

Among recent developments are preparations of vinyl acetate copolymers and terpolymers that give resins of improved water resistance.

POLYVINYL CHLORIDE-ACETATE

Copolymerization of vinyl chloride with vinyl acetate results in a material which retains the toughness and chemical resistance of polyvinyl chloride and has increased flexibility. These copolymers are odorless, tasteless, water-resistant, and self-extinguishing; they possess good dielectric properties and a low order of toxicity. The vinyl chloride content in these copolymers varies from 85 to 97 percent. Both solution and suspension polymerization techniques are being used to manufacture this type of resin.

Also like their parent polymers, vinyl chloride-acetate resins are modified by the addition of plasticizers, heat stabilizers, pigments, and fillers to obtain a variety of products. They are supplied as sheets, rods, tubes, granules, powders, and dispersions, and may be fabricated by standard molding, extrusion, calendering, casting, and coating techniques.

Vinyl chloride-acetate copolymers have been particularly useful as coatings and in the form of unplasticized sheets. These copolymers are ideal for the formulation of solution coatings for a variety of applications. They may be dissolved in ketones, ethers, esters, and chlorinated hydrocarbons. Aromatic hydrocarbons, such as xylene and toluene, are commonly employed as diluents. As sheets, these resins are produced commercially with calendered, matte, or planished finish in a variety of thicknesses, colors, and degrees of transparency. One of the fastest-growing applications for these resins is skin-packaging with cast vinyl film. In this process, film, made by casting dispersions onto a metal belt, is vacuum drawn tightly over the items to be packaged.

Durable, flame- and chemical-resistant fabrics, protective clothing, and filter and anode bags may be woven from extruded vinyl chloride-acetate resin monofilaments, which are shrink-resistant at normal temperatures. Elas-

tomeric materials compounded from this polymer have excellent abrasion resistance, tensile strength, and flexibility over a wide range of temperatures. Elastic sheeting and film of vinyl chloride-acetate resins are used for upholstery, handbags, luggage, gaskets, and packaging applications. Vinyl chloride-acetate resin elastomers may be extruded into rods or tubes for electrical jacketing and insulation.

POLYVINYL ACETALS

These resins differ from polymers of vinyl chloride and vinyl acetate in that they do not result from the polymerization of monomer. Instead, polyvinyl acetals are produced from a condensation of polyvinyl alcohol with an aldehyde. A polyvinyl acetate of a desired molecular weight is first dissolved in a solvent such as methanol and then hydrolyzed to polyvinyl alcohol. This hydrolysis product is reacted with an aldehyde in the presence of moderate heat and a suitable catalyst such as sulfuric or hydrochloric acid to yield a typical cyclic acetal structure. There are three main groups of polyvinyl acetals—polyvinyl acetal itself, made with acetaldehyde, polyvinyl butyral, and polyvinyl formal—all having outstanding adhesive qualities.

Polyvinyl acetal: This resin is used most often in adhesives, impregnating coatings, photographic film, sheets, rods, and tubes. Because vinyl acetal resins have a slight yellowish cast, their usefulness is limited to applications in which color is not a decisive factor. Polyvinyl acetal is processed by casting, coating, extrusion, and molding.

Polyvinyl butyral: Because of its high degree of clarity, even under adverse conditions of moisture, heat, and cold, this resin is best known for its use as an elastic sheeting for safety-glass interlayers. However, it also performs in an outstanding fashion as a base for wash primers or metal conditioners. Applied in an extremely thin film, this conditioner provides an excellent adhesive bond for subsequent coats as well as a temporary resistance to corrosion. Phenolic, alkyd, and oleoresinous paints adhere to the wash primer, usually with improved performance. This primer permits an all-vinyl system to be used in marine and industrial applications. For this application, and for molding compounds, vinyl butyral resins are supplied as solution-grade granules. These resins can also be cross-linked by phenol-formaldehyde and urea-formaldehyde resins to produce coatings and adhesives for bonding rubber, cork, asbestos board, wood, glass, ceramics, cloth, paper, metals, and phenolics.

Polyvinyl formal: Used chiefly in wire coatings in combination with cresylic phenolics, or other impregnants, these resins can also be molded, extruded, or cast. Like polyvinyl butyral, this resin resists alkalies, greases, oils, and water. However, it is not as compatible with other resins as is polyvinyl butyral.

POLYVINYL ALCOHOL

Since vinyl alcohol does not exist in monomeric form, vinyl alcohol resins cannot be prepared by direct polymerization. They are produced by the hydrolysis of polyvinyl acetate in an alcohol solution, using acid or alkali catalysts. Acid catalysis is preferred since it has been found that alkaline hydrolysis gives an undesirable color to the product. The degree of hydrolysis is a governing factor in the properties of the end products. These resins are generally soluble in water.

Polyvinyl alcohol resins are processed by molding, extrusion, and solution coating. These resins produce tough, flexible products that are impervious to gases and water-insoluble solvents, such as aromatic and aliphatic hydrocarbons, chlorinated hydrocarbons, and animal and vegetable oils.

Products made from these resins are used in industrial hose assemblies, lubrication systems, X-ray equipment, and in laboratory and pilot plant installations. In sheet or molded form they are used as diaphragms, gaskets, and friction rollers.

Presently, efforts are underway to improve the water resistance of these materials. Partial acetylation has been one method tried. Another development with this resin is a novel copolymer made with silane monomers for use as a varnish. Other new applications for polyvinyl alcohol are sponges and sizings for glass fibers.

POLYVINYLIDENE CHLORIDE

When vinylidene chloride is polymerized alone or copolymerized with vinyl chloride, a series of resins is produced, ranging from a flexible, moderately soluble material with a softening point of about 160° F., to a hard, tough product with a softening point of 335° F. or more. These resins are characterized by extremely low water vapor-transmission, and exceptional oil, grease, and chemical resistance, These properties are due at least in part to the high crystallinity of the resin.

The basic resins are nonflammable and are soluble only in cyclic ethers and ketones. The insolubility in most chemicals of some vinylidene chloride resins allows them to be used in many applications requiring exceptional chemical resistance. These polymers are compatible with very few other resins and plasticizers; however, they can be modified for specific applications.

Polyvinylidene chloride resins have been found particularly well-suited for injection molding and extrusion. Extruded and oriented, these resins are used in weaving upholstery fabrics, draperies, and weather-resistant screening, as well as for rigid pipe and fittings. In film form, polyvinylidene chloride resins are used for a variety of heat-sealing packaging applications.

Vinylidene chloride has been used most often when copolymerized with vinyl chloride. Because of the greater solubility of this copolymer, these resins are more valuable in the solution coating field than is either homopolymer. Copolymers of vinylidene chloride-vinyl chloride can be used in metal and fabric coatings and in casting or calendering films. These films and coated materials can be easily heat-sealed at

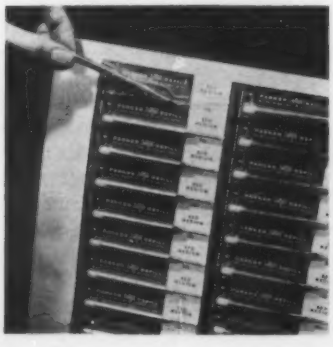
temperatures ranging from 275 to 320° F. The copolymers can also be extruded to produce flexible tubing and electrical insulation for a variety of different applications. Polyvinylidene chloride copolymerized with acrylonitrile also possesses certain advantages for specialized end uses.

OTHER VINYLS

Polyvinyl alkyl ethers: These resins are the result of the homopolymerization and copolymerization of the end-products of the catalytic addition of acetylene to aliphatic alcohols. Polyvinyl methyl ether is a linear polymer characterized by its solubility in an extremely wide variety of solvents, its tacky nature, its solubility in cold but not hot water, and its compatibility with numerous other resins and polymers. It is supplied in unmodified form in 50% aqueous solution, or in 50% solution in various organic solvents such as isopropanol and toluene. Included in this class of resins are vinyl methyl ethers, vinyl ethyl ethers, and a linear copolymer consisting of alternating methyl vinyl ether and maleic anhydride units. This latter resin is soluble in both water and organic solvents. These resins offer good aging characteristics, low order of toxicity, ease of processing, and good adhesive qualities. Applications include pressure-sensitive adhesives, tackifiers in adhesives, and binders in paper, textile, and leather industries.

Considered particularly useful as an ingredient in making pressure-sensitive adhesives are polyvinyl ethyl ethers. For this application, these resins are compounded with varnish-type phenolics or rosin derivatives. In the form of high-molecular-weight resins, polyvinyl ethyl ethers are sold as solvent-free slabs or in heptane solution. Low-molecular-weight polyvinyl ethyl ethers are sold as solvent-free, very viscous liquids and also in heptane solution.

Small items, such as ball-point pen refills, can be economically skin-packaged in cast vinyl film. (Photo, Bakelite)



Polyvinyl pyrrolidone: This resin is prepared by the controlled polymerization of 1-vinyl-2-pyrrolidone to yield products of varying molecular weights. Generally supplied as a white powder that is soluble in water and a great number of organic solvents, the polymer is compatible with many plasticizers, including glycerol, sorbitol, and the ethylene, diethylene, and polyethylene glycols. It is also compatible with polyvinyl alcohol in various ratios.

Because of its inherent inertness and low toxicity, polyvinyl pyrrolidone is extremely important in biological and pharmaceutical applications. It has been found particularly useful as an extender for blood plasma for treatment of shock, certain diseases, and vascular disorders. Other uses of this resin include a gelatinous substitute for photographic emulsions, an agent to increase the solubility of iodine and certain dyes, a stripping agent for textile dyes, a dispersing agent in suspension polymerization, and more recently as an ingredient in hair sprays.

Polyvinyl carbazole: This resin is produced by the polymerization of monomeric *N*-vinyl carbazole, a product of the reaction between carbazole and acetylene. The most outstanding characteristics of these resins are their electrical and chemical resistance. They are resistant to acids and alkalies, and are insoluble in aliphatic hydrocarbons, alcohols, ethers, carbon tetrachloride, and paraffin oils. The impact strength of vinyl carbazole resins is low, but it can be improved by extrusion-orienting the material into fibers at 430° F. These resins are processed by molding, impregnating, or coating.

New vinyl resins: One of the most recently-developed vinyl resins, polyvinyl naphthenate, is particularly useful as a thickener. Copolymerized with vinyl acetate, it promises to be extremely useful as an interlayer for safety glass. Polyvinyl benzoate and polyvinyl fluoride are two other new resins which look promising.

References

Consult the Subject Index for additional information concerning vinyl polymers and copolymers. For specific information on injection molding, see p. 650; extrusion, see p. 702. See the Adhesives, Coatings, Films, Foamed Plastics, and Plastics Properties Charts for information on properties and trade designations. For sources of vinyls, see Directory Index, p. 1018.

"Vinyl cast on paper carrier," MODERN PLASTICS *34*, 126 (Dec. 1956).

"Portable ditch," MODERN PLASTICS *34*, 110 (Nov. 1956).

"Chrome protected by vinyl spray," by H. Chase, MODERN PLASTICS *34*, 147 (Oct. 1956).

"Plastisol viscosity—temperature characteristics," by W. D. Todd, D. Esarove, and W. M. Smith, MODERN PLASTICS *34*, 159 (Sept. 1956).

"Vinyl lining prevents water seepage," MODERN PLASTICS *33*, 180 (July 1956).

"Improved ester - plasticized polyvinyl chlorides," by W. F. Fischer and B. M. Vanderbilt, MODERN PLASTICS *33*, 164 (May 1956).

"The economic stabilization of vinyl chloride polymer," by H. V. Smith, Brit. Plastics *29*, 373 (Oct. 1956).

"Vinyl epoxy stearate: preparation, polymerization, and properties of polymers and copolymers," by L. S. Silbert, Z. B. Jacobs, W. E. Palm, L. P. Witnauer, W. S. Port, and D. Swern, J. Polymer Sci. *21*, 161 (Aug. 1956).

"Vinyl laminate," by C. F. Kiernan and A. J. Lombardi, Product Eng. *27*, 167 (July 1956).

"Window shades in vinyl," Modern Packaging *29*, 99 (Apr. 1956).

"Industrial applications for dispersions of vinyl resins," by R. L. Norum, SPE J. *12*, 21 (Jan. 1956).

Rigid Vinyls

BY JEAN F. MALONE*

RECENT DEVELOPMENTS

Rigid polyvinyl chloride pipe, valves, and fittings (*Koroseal*, B. F. Goodrich Industrial Products Co.) make it possible to handle active hypo and developer solutions used in film processing like water. In a new motion picture processing laboratory (Consolidated Film Industries), a network of more than 1600 ft. of polyvinyl chloride pipe, 1/10th the cost of special stainless steel pipe and weighing 25% less, carries the solutions through the entire system.

Rigid polyvinyl chloride pipe is to be used by the U.S. Navy for carrying sea water to wash down all exterior parts of a vessel that has been subject to contamination by radioactive fallout. Every ship in the Navy will be thus equipped. Navy specifications are MIL-P-19119 (Bureau of Ships), Nov. 8, 1955, and two amendments, No. 1, April 27, and July 2, 1956.

Polyvinyl chloride lining (*Fligid*, Kaykor Industries, Inc.), for protecting tanks, vessels, and other process equipment against corrosion, is now available in two standard thicknesses, 0.055 in. (*Fligid-55*) and 0.085 in. (*Fligid-85*). The lining, a continuous laminate of plasticized and unplasticized polyvinyl chloride, combines the strength and corrosion resistance of the unplasticized material with the ability of the plasticized PVC to be bonded to other materials.

Vinyl cement (*VC-2*, Schwartz Chemical Co.) is used in bonding rigid polyvinyl chloride pipe for use in such underground installations as sprinkler systems and irrigation projects. The pipe can be joined as soon as it is cemented. In 10 to 15 min., the cement dries.

Unplasticized polyvinyl chloride pipe, duct, and sheeting (*Ryertex Omicron*, Corroplast, Inc.), for chemical- and corrosion-resistant applications, is made from a special low-molecular-weight resin (*Vipla*, Chemore Corp.).

A modified rigid polyvinyl chloride compound (*Vygen 2201*, General Tire Co.) for calendering does not have the rubbery nerve frequently found in rubber-resin blends and has a minimum of heat build-up during processing. A 30-mil sheet can be drawn 9 in. deep.

New equipment (Masland Duraleather Co.) produces rigid vinyl sheets up to 54 in. wide and 102 in. long. Various thicknesses can be achieved, and all materials are laminated and stress relieved.

Rigid polyvinyl chloride materials, also known as unplasticized PVC, were hardly more than a subject of exploratory interest in the United States prior to 1950. Since that time, their unique combination of chemical and physical properties has become well-known. The chemical inertness of rigid vinyls is often their prime recommendation. They can withstand many strong acids and alkalies, metallic and ammonium salts, and organic media such as alcohol and aliphatic hydrocarbons. These excellent chemical properties are combined with equally advantageous physical characteristics. Tensile and flexural strength, abrasion resistance, and heat distortion temperature are among the best of the thermoplastics. In addition, rigid PVC materials will not support combustion, they can be formed on conventional equipment, and their electrical and aging properties are excellent.

* Product Engineer, Plastic Materials, B. F. Goodrich Chemical Co., Cleveland, Ohio.
Recent Developments and References were prepared by the editors.

Classification

At present, there are three distinct types of rigid vinyl. A copolymer of polyvinyl chloride was developed somewhat earlier than the straight PVC types. It has succeeded in capturing a large share of the market in the record industry and is extensively used to make sheet for binder covers, playing cards, relief maps, advertising displays, lighting components, and embossed and patterned wall coverings. The recent development of extruded sheet will probably support a sizable increase in the sale of PVC copolymer to the packaging field and may initiate active competition in the manufacture of refrigerator liners. Projected figures for 1965 indicate that the total volume for rigid vinyl sheet should approach 50 million pounds. Of this volume, the largest portion will be based on PVC copolymers.

The two rigid PVC types are straight, unplasticized polyvinyl chloride. A normal-impact PVC, commonly referred to as Type I, is stronger, more rigid, more resistant to chemicals, and has a higher temperature service range than its companion polymer. Type II is modified during the manufacturing process to obtain increased resistance to impact. The slight loss in chemical and physical properties that results from this modification is not sufficient to interfere with its use except in the most critical applications.

There is a significant difference between the products usually made of the two rigid PVC materials and those made of the rigid copolymer. The latter is predominant in the field of rigid sheet and postformed variations of sheet, while the straight PVC plastics have been successful in heavier structural designs. Both normal- and high-impact stock are extensively used for pipe,

pipe fittings, valves, heavy-gage panels, and many specialized extruded components such as electrical ducts, window and door framing elements, and architectural moldings.

The variations in physical properties among the three rigid vinyl types determine to a large extent their general areas of use. As shown in Table I, below, the values for many properties are mainly equivalent, but distinctive differences do occur in various other properties.

Extrusion of rigid vinyl

Although molding and calendering are important methods of forming normal- and high-impact PVC, extrusion consumes the largest volume and is very likely to increase its lead in the years immediately ahead. A large amount of credit for the growth of extruded products must be given to the improved processing techniques that have been developed. Laboratory and production data have accumulated to the point that reliance on trial and error and personal skill has been largely supplanted by a body of sound technical knowledge. As a direct result, high standards have been established for pipe and tubing, and new markets have been encouraged.

The extrusion of pipe, as an example, has progressed in quality and has become sufficiently standardized to accurately predict performance under specified conditions. Large cross-sections are much less a problem than they once were. A 14-in. pipe, for example, is now being produced as a commercial item. Despite its size, the surface finish is excellent, and roundness and wall thickness are maintained within very small tolerances.

An increasing amount of rigid PVC is being used to extrude custom shapes. In addition to the familiar chemical and outdoor aging characteristics of rigid PVC, many custom applications require strength in thin cross-sections, smooth finish, a wide choice of color, and excellent dimensional stability. These qualities have contributed to the success of window framing and tracks, sliding door channels, trim components for cameras, air conditioning units and refrigerators, architectural moldings, and many other similar designs. Many of the parts listed above bring rigid PVC in direct competition with aluminum and other metals, but increased production rates and lower material costs are closing the margin that originally favored the use of metals.

Improvements have also been made in the design of dies for the extrusion of rigid PVC sheet. Sheet varying from 5 to 120 mils with good uniformity in thickness across the width has been extruded in pilot operations. Dies up to 24 in. in width have already been tested with excellent results. The rate of production is good, and the appearance of the sheet has been generally clear and free of faults. From all reports the development of wider dies will soon prove equally successful. The lower cost of extruded rigid PVC sheet should promote more active participation in competitive areas previously dominated by other plastic materials.

TABLE I: Physical properties of rigid vinyls

	A.S.T.M. Method	*Rigid vinyl copolymer*	*Rigid PVC Type I*	*Rigid PVC Type II*
Specific gravity	792-47T	1.37-1.45	1.38	1.35
Tensile strength, p.s.i.	638-49T	7500	8500	6000
Flexural strength, p.s.i.	790-49T	12,000	13,500	12,000
Flexural modulus, 10^5 p.s.i.	790-49T	4.5-5.0	5.0	3.5
Izod impact, ft.-lb./in. of notch @ 72°F.	256-47T	0.5	0.8	15
Izod impact, ft.-lb./ in. of notch @ −20°F.	256-47T	0.2	0.3	1
Thermal expansion 10^{-5}/°C.	696-47T	7	5	10
Heat distortion, °F. @ 66 p.s.i.	468-45T	—	168	158
Heat distortion, °F. @ 264 p.s.i.	648-45T	145	165	155
Rockwell hardness	785-48T	—	R110	R105
Moisture absorption % in 24 hr.	570-42	0.08	0.05	0.10
Dielectric strength, short time, v./mil	D149-44	425	1400	1100
Dielectric constant @ 10^6 cycles	D150-47	3.0	3.0-3.5	—
Ultra-violet resistance		Good	Good	Good
Heat formability		Good	Fair	Fair
Flammability, in./min.	D635		Self-extinguishing	
Thermal conductivity, 10^{-4} cal./cm.^{2}/sec./°C.		3.7	3.5	4.5

Markets and prospects

The markets for rigid polyvinyl chloride are most commonly divided between pipe, pipe fittings, extruded profiles, and formed sheet applications. Taking this more or less arbitrary division

as a guide, the markets for rigid vinyl products can be outlined as follows:

Pipe: Anticipated volume for 1960 is approximately 50 to 60 million lb., and the growth in use of vinyl pipe is still so active that many predict that this rate of increase will be maintained for a considerable length of time. Foremost applications for rigid vinyl pipe and the reasons that vinyl pipe can be expected to grow in these various fields are listed in Table II, right.

Extruded profiles: Specialized shapes have been expanding very rapidly and can be expected to consume several million pounds by 1960. Gutters, downspouts, framing elements, automotive trim, protective rails, and literally hundreds of other shapes contribute their share.

Sheet: The total of 50 million lb. of rigid vinyl sheet predicted for 1965 consumption will be divided among the classifications listed in Table II, right. There should be a natural expansion in all these applications when the extrusion of sheet becomes commercial, but particular growth may be expected in packaging, laminates, and lighting components. Lower costs should also encourage expansion into new markets such as refrigerator liners, housings, and luggage.

TABLE II: Applications of rigid vinyls

PIPE

Application	*Reasons for use*
Oil fields	Resistant to crude oil and salt water. Very low paraffin build-up.
Gas mains and service lines	Resistant to the impurities carried in natural gas. Not affected by electrolytic corrosion when buried.
Irrigation	Light, easy to install. Can be buried and will maintain full flow for extended periods of time.
General service	Noncontaminating. Easy to install and requires no maintenance.
Chemical industry	Will resist most acids, alkalies, and widely used commercial solvents.
Conduit	Good electrical properties, tough, and resistant to weathering and age. Nonflammable.

SHEET

Application	*Reasons for use*
Packaging	Noncontaminating, clear, easily printed.
Transportation	Durable, waterproof, easily maintained.
Signs and displays	Easily formed. Wide choice of color. Can be silk screened, lithographed, or preprinted.
Lighting and glazing	Good transmission of light, flame-resistant, dull finish for excellent diffusion.
Decorative laminates	Strong, nonflammable, wide choice of color, smooth or embossed finish.
Chemically resistant applications	Inert to most chemicals, easily fabricated, durable, and relatively inexpensive.
Graphic arts	Wide choice of color, fine detail, and easily printed by a variety of methods.
Electrotyping	Takes a fine, clean impression, and is resistant to inks, abrasion, and flexure.
Playing cards	Easily printed in color, easily cleaned, and very durable.
Records	Molds to a very fine detail, improving fidelity and eliminating surface noise. Virtually unbreakable.
Notebook binders	Tough, flexible, variety of color, and easily printed.
Contour maps	Easily and accurately formed; can be colored and printed.

Standards and specifications

The Society of the Plastics Industry has been successful in establishing commercial standards for both rigid sheet and pipe. Late in 1955, the standard for sheet (CS201-55) was published by the U. S. Dept. of Commerce. It governs dimensions and allowable tolerances, uniformity of color, transparency, and finish, and specifies certain chemical and physical requirements. A similar code for pipe (CS207-57) sets specifications for outside diameter, wall thickness, and roundness in cross-section. Standards for hydrostatic burst, impact tests, immersion, flattening, and heat shrinkage are also being considered at the present time. The Bureau of Ships and Army Ordnance, recognizing the increasing importance of rigid vinyls, have developed their own specifications for extrusion and molding compounds, as well as for pipe and sheet.

References

Consult the Subject Index for additional information on rigid vinyls. See also the Plastics Properties Chart for information on properties and trade designations. For sources of rigid vinyls, see Directory Index, p. 1018.

"Showerbaths for warships," by M. Malamut, W. R. Graner, and J. J. Kearns, MODERN PLASTICS *34*, 129 (October 1956.)

"Roll bending," by M. Jukich, MODERN PLASTICS *33*, 138 (Apr. 1956).

"Vinyl glazing," MODERN PLASTICS *32*, 202 (Aug. 1955).

"Rigid vinyl food package," Modern Packaging *28*, 82 (July 1955).

"PVC ducting for mining ventilation," by F. W. Raspass, Brit. Plastics *28*, 86 (Mar. 1955).

"Rigid vinyl formulations," by L. Kuhn, Brit. Plastics *28*, 31 (Jan. 1955).

Vulcanized Fibre

BY J. MACADAM*

One of the oldest plastic materials known to industry, vulcanized fibre is basically a laminate built up from cotton cellulose paper. It differs from other laminates in that the layers of paper are bonded together by the gelatinized surfaces of the cellulose fibers. No added adhesive, resin, or other binder is needed.

The special type of waterleaf paper used for vulcanized fibre manufacture is made in a wide variety of weights, colors, and physical qualities. In the production process the paper is saturated with zinc chloride, which causes the individual cellulose fibers to swell and become covered with a layer of gel. This gelatinized cellulose flows together and so bonds the contacting fibers and layers of paper. Lamination is improved by use of heat, pressure, and time under carefully controlled conditions.

Properties

Based on unit weight (about half that of aluminum), vulcanized fibre is one of the strongest materials available to industry. Depending on grade, tensile strength ranges from 6000 to 12,000 p.s.i.; flexural strength limits are 12,000 to 20,000 p.s.i.; compressive strength is 20,000 to 30,000 p.s.i.; shear strength is 12,000 to 15,000 p.s.i.; and impact strength is 4 to 8 ft.-lb./in. of notch. Rockwell hardness is R60 to R100 and the modulus of elasticity is 750,000 p.s.i. This combination of qualities gives a material capable of absorbing repeated shock and impact loads. Dielectric strength varies with thickness, to values over 300 v./mil. Vulcanized fibre is "Class A" insulation and in heat resistance is superior to cellulose insulation of the unconverted type.

Indicative of the expanding field for this versatile material is the new list of grades defined by N.E.M.A.

Grades

Electrical insulation grade is primarily intended for electrical applications and others involving difficult bending or forming operations. It is sometimes referred to as fishpaper.

Commercial grade is considered the general-purpose grade, sometimes referred to as "Mechanical and electrical grade." It possesses good physical and electrical properties and fabricates well.

Bone grade is characterized by greater hardness and stiffness associated with higher specific gravity. It machines smoother with less tendency to separate the plies in difficult operations.

Trunk and case grade conforms to the mechanical requirements of "Commercial grade," but has better bending qualities and smoother surface.

Flexible grade is made sufficiently soft by incorporating a plasticizer to make it suitable for gaskets, packing, and similar applications. It is not recommended for electrical use.

Abrasive grade is designed as the supporting base for abrasive grit for both disk and drum sanders. It has exceptional tear resistance, ply adhesion, resilience, and toughness.

White tag grade has smooth clean surfaces and can be printed or written on without danger of ink spread.

Bobbin grade is used for the manufacture of textile bobbin beads. It punches well under proper conditions, but is firm enough to resist denting in use. It machines to a very smooth surface.

Railroad grade is for use as railroad track joint, switch rods, and other insulating applications for track circuits. It conforms to A.A.R. Signal Section Specification for Hard Fibre.

Hermetic grade is used as electric motor insulation in hermetically sealed refrigeration units. High purity and low methanol extractables are essential because it is immersed in the refrigerant.

White grade is recommended for applications where whiteness and cleanliness are essential requirements.

Shuttle grade is designed for gluing to wood shuttles to withstand the repeated pounding received in power looms.

Pattern grade is made to have best dimensional stability and least warpage for use as patterns in cutting cloth, leather, and similar materials.

Hamper, trimmed with high-impact styrene, is made of cold embossed vulcanized fibre. Good dimensional stability and chemical resistance dictated choice of material



References

Consult the Subject Index for additional information concerning vulcanized fibre. See also the Laminates Chart for information on properties and trade designations of vulcanized fibre. For sources of vulcanized fibre, see Directory Index, p. 1018.

"Vulcanized fibre manufacture in Germany," by G. M. Kline and R. Richardson, MODERN PLASTICS 23, 196 (April 1946).

"Vulcanized fibre is strong, tough, hard, and easy to work," by G. A. Albert, Materials and Methods 27, 88 (April 1948).

* Applications engineer, National Vulcanized Fibre Co., Wilmington, Del.
References were prepared by the editors.

Resins for Coatings

BY R. A. CALSIBET*

Protective coatings have been used since prehistoric times, but nitrocellulose was one of the first man-made materials used in coatings. First employed in 1855, it was manufactured from wood pulp and nitric acid. Since that time, nitrocellulose has been used in a great variety of industrial lacquers—and is still extensively used today.

Coumarone-indene resins appeared after 1910 and were the first truly synthetic materials available for varnish making. Another very important development at this time was the discovery by Leo H. Baekeland of the first practical phenol-formaldehyde plastic. These new materials marked the beginning of the modern plastics industry. Coating uses, however, were restricted by non-oil solubility.

One of the first applications was the use of baking lacquers for brass beds. This coating was an alcohol solution of a phenolic.

Later, the "Albertols" were developed. These were phenolics modified with natural resins or esters to provide oil-solubility.

The next milestone in the development of synthetic coating resins came in 1928 when a substituted 100% phenolic resin, soluble in drying oils, was developed. This made possible the familiar phenolic varnishes.

After 1928, new coating resins appeared regularly. As each new material took its place, it naturally replaced a number of old material uses, but also developed new markets of its own. Alkyd resins became very important after 1930 and have grown to where they now account for 60% of protective coating resins.

Vinyl coating resins were introduced in the early thirties and acrylate and methacrylate resins for coatings appeared shortly thereafter. Amine resins and chlorinated rubbers also came into the picture about this time.

Styrene resins entered the coatings field about 1937 in the form of a water emulsion, but did not achieve importance until the advent of water-base paints.

The coming of World War II created a tremendous need for all sorts of plastic materials. In the coatings field, in particular, resins came into greatly increased demand for use in the protection of all sorts of critical wartime equipment—as well as to protect against a wide variety of new and difficult conditions that paints had not had to withstand previously. Such was the preoccupation with wartime materiel, however, that the tide of new developments was sharply curtailed.

Probably the most spectacular plastic that grew out of the war was polyethylene. Its use in coating packaging materials such as paper, cellophane, foil, and boxboard has mushroomed over the past decade. Epoxy resins were developed during the war, but were not marketed commercially until later. They have since exhibited an impressive growth pattern in coating metals and other materials. Another extremely fruitful wartime invention was the vinyl butyral wash primer or metal conditioner. First used to protect U. S. Navy ship bottoms, wash primers have now spread to many other applications where metals must be so protected.

Following the war, the development of new techniques and materials was resumed in force, and there have been remarkable strides in the last decade: vinyl dispersions for cloth and metal coatings; vinyl acetate, acrylic, and styrene-butadiene latices for wall paints; styrenated alkyd paints; and petroleum and polyterpene resins for varnishes. A new development in 1954 was the "cold-mix" technique of phenolic varnish preparation which obviated cooking the vehicle.

Cellulose derivatives

Chemistry and manufacture: Cellulose derivatives are prepared by reacting either cotton linters or specially prepared wood pulp with appropriate reagents. All the derivatives can be prepared with varying degrees of substitution and polymerization. Substitution occurs by reaction with the hydroxyl groups of the cellulose molecule. Solubility and compatibility characteristics can be adjusted by varying the type and amount of substitution. Cellulose itself is a very high-molecular weight material, and manufacture of derivatives always involves a reduction in the chain length. As the molecular weight is reduced, solution viscosity, tensile strength, and flexibility are all lowered.

Properties and major applications: Cellulose esters are useful in the preparation of lacquers, and include cellulose nitrate (nitrocellulose), cellulose acetate, cellulose acetate butyrate, and cellulose ethers. Cellulose nitrate is the most widely used derivative for coatings. It is soluble in many solvents, compatible with many resins and plasticizers, and has excellent interior and exterior durability. Almost all cellulose nitrate lacquers are sold for industrial use; the largest markets are auto and furniture finishes.

Cellulose acetate has outstanding clarity and ultra-violet color retention, and has moderate heat- and greaseproofness as well as solvent resistance. It is soluble in only a few high-cost solvents and is not compatible with many other resins and plasticizers. It is used in specialty lacquers where greaseproofness is an asset.

Cellulose acetate butyrate is a mixed ester with wider compatibility with resins and plasticizers than the straight acetate. It is noted for clarity and resistance to discoloration. Cellulose acetate butyrate is used in clear aluminum or aluminum foil coatings, paper coatings, and others.

There are two important celluluose ethers. Ethyl cellulose is used to prepare specialty coatings where alkali resistance, color

* Manager, Surface Coating Materials Div., Industrial Products Dept., Bakelite Co., a Div. of Union Carbide Corp., 30 E. 42 St., New York, N. Y.

Recent Developments and References were prepared by the editors.

Primer coatings are available (National Starch Products Inc.) which provide good adhesion between polyethylene extrusion coatings and such difficult-to-adhere substrates as polyester film (*Mylar*) and foil. These coatings dry tack-free and can be formulated with typical flexographic ink solvents thus giving versatility in the method of application. According to the manufacturer, presence of primer permits lower extrusion temperatures, thereby minimizing possibilities of oxidation and resultant odor formation in the polyethylene.

Half of the latex paint sold in 1960, according to a recent estimate, will be of the polyvinyl acetate type, as compared with about 20% in 1956. In 1948, sales of all latex paints amounted to 2 million gallons; by the end of 1956, they were selling at the rate of 60 million gallons per year.

A free-flowing powder (*Whirlsint K-51*, National Polymer Products, Inc.) specially prepared for use in a coating process (*Whirlclad*) developed by the manufacturer is basically formulated from chlorinated polyethers. Coatings obtained from this material are said to have exceptional chemical resistance, good dimensional stability, excellent mechanical properties, and outstanding electrical characteristics over a wide temperature range.

Two fast-curing surface coating resins (*Cyzac 1006* and *Cyzac 1007*, American Cyanamid Co.) provide maximum hardness and much greater impact and chemical resistance than conventional finishes. Other properties claimed for these "nitrified ester resins" are flexibility, high initial gloss and excellent gloss retention, unusually good enamel stability, and better adhesion than conventional finishes. One of these coating resins (*Cyzac 1006*), generally used with a primer, is intended for applications in which color retention and the hardness-impact relationship are important. The other (*Cyzac 1007*), generally used without a primer, gives baked finishes with unusually good adhesion and impact resistance, and for many applications may be applied over unprimed steel.

A universal spray finish (*Logo R-200*, Logo, Inc.) works well on all polystyrenes and polystyrene copolymers, butyrate, phenolics, polyesters, and other materials.

A colloidal dispersion (*Dispersion No. 235*, Acheson Colloids Co.) of metallic copper in a lacquer solution provides a highly conductive surface coating to nonconductors. It is suggested for printed circuitry, electroplating of nonconductors, and for application on components of radar equipment, hearing aids, and electronic measuring devices. The dispersion is cheaper than other coatings and is applied easier than copper foil.

A brushable coating (*Coverlac SC-242C*, Spraylat Corp.) can be used as a mold release for epoxy resin laminates on plaster molds, as a barrier release coating on metals against epoxy or other adhesive resins during bonding operations, and for masking metal surfaces during spraying and baking cycles. The coating air-dries to form a waterproof, chemical-resistant film that has good heat resistance and is easily peeled from the formed part. The same compound is available in a sprayable consistency (*Coverlac SC-242C-1*).

Two epoxy coating resins (*Maraset gray enamel No. 750* and *Maraset clear varnish No. V760*, Marblette Corp.), characterized by strong adhesion to a variety of materials and excellent resistance to a wide range of chemicals, are useful as an anticorrosion protective coating for chemical equipment.

Sprayable plastisol compounds (*Flintlok* and *Tufkote*, Auburn Button Works) are available in a range of specifications. One group (*Flintloks*) are recommended for coating interiors of storage tanks and processing equipment subject to corrosion, and for application to machinery, to appliances, to equipment, and all metal products. Another group of plastisol sprays (*Tufkotes*) give a thicker, more cushiony coat in textures ranging from shiny or satin to pebble, wrinkle, or leather grain.

A two-component low-density polyurethane coating (*Laminar X-500*, Magna Coatings & Chemical Corp.), catalyzed for air cure, is recommended for protecting magnesium, aluminum alloys, and other metals (ferrous and nonferrous) against corrosion. Available in colors, it can be used on reinforced plastics and wood.

---

stability, low-temperature flexibility, toughness, or good electrical properties are desired. This ether is compatible with waxes, which leads to its use in paper coatings. Other applications include strippable coatings, bowling pin coatings, and cable lacquers. Ethyl hydroxyethyl cellulose is a new entrant in the field. This ether has aliphatic hydrocarbon solubility, and is used widely in silk screen printing inks, where the aliphatic solvents make for better working conditions.

Phenolic resins

Chemistry and manufacture: Phenolic resins are condensation polymers of a phenol and some material that supplies methylene ($-CH_2-$) or substituted methylene linkages, usually formaldehyde. In addition to phenol itself, a number of substituted phenols are commonly used in the production of coating resins. Each of these phenols imparts its own particular group of characteristics to the resin. In general, ortho-

and para-substituted phenols yield oil-dispersible resins, while meta-substituted and pure phenols lead to indispersibility.

The catalyst greatly affects the reaction. Acid catalysts promote rapid resin formation and permanently thermoplastic products. With alkaline catalysts, the reaction proceeds more slowly and oil-insoluble products result unless stopped at an intermediate stage.

Properties and major applications: There are four important types of phenolic resins used in coatings. The *thermoplastic oil-soluble resins* or phenolic varnish resins can be incorporated into a wide variety of coating formulations outstanding in durability, drying speed, water resistance, and toughness. Resistance to many chemicals and solvents is excellent, but strong acids and alkalies should be avoided.

The varnish resins find important uses in spar varnishes; marine and fresh water primers and enamels; structural steel primers and enamels; industrial maintenance finishes; and many others where the maximum weathering protection is required.

The *thermosetting oil-soluble resins* are widely used to upgrade varnishes based on inexpensive natural resins such as rosin and ester gum. The results are markedly improved drying speed, water resistance, chemical and solvent resistance, and durability. These resins greatly accelerate the viscosity-increase rates of oils in the varnish kettle. They are often processed with blown oils to produce air-drying coil impregnating varnishes that are completely through-curing, tough, and solvent-resistant.

The *thermosetting non-oil-soluble resins* are alcohol-soluble baking coatings, and are used where the highest order of chemical and solvent resistance is desired. These materials are used in tank and tank-car linings for milk, wine, and acid. They are also used in many types of chemical processing equipment. In addition, they are compounded into coatings for drums, pails, and other fabricated metal products requiring high chemical and abrasion resistance.

The *phenolic dispersions* are a distinctive class of coating materials. They consist of a dispersion of highly polymerized oil-resin particles in aliphatic or aromatic hydrocarbon liquids. They dry readily, solely by solvent evaporation. In combination with varnishes or alkyds, they form tough, durable, fast-drying, moisture-resistant films having good adhesion to metals. Dispersion finishes are often recoated with lacquer after drying. They are used in corrosion-resistant aircraft primers, quick-drying shop coats, metal product primers, traffic paints, and lacquer undercoats.

Alkyd resins

Chemistry and manufacture: Alkyd resins are normally defined as branched-chain polyesters which have been modified with fatty monobasic acids of the unsaturated type. "Polyester," on the other hand, usually refers only to linear condensation products of glycols and dibasic acids.

The amount and type of oil modification in alkyd resins exerts a profound effect on the final coating properties. Those modified with saturated fatty acids are of the permanently liquid or nondrying type. They are used only as modifiers or plasticizers for nitrocellulose and amine-formaldehyde type resins. Those alkyds modified with unsaturated or "drying"-type fatty acids, harden or "dry" into films, either by air-drying or baking. Alkyds generally contain 30 to 70% oil.

Properties and major applications: Short-oil alkyds contain fewer aliphatic fatty acid chains and hence tend to be incompatible with aliphatic solvents. They are usually supplied as solutions in aromatic solvents. Short-oil alkyds using nonoxidizing oil acids such as coconut or castor are widely used as plasticizers for cellulose nitrate formulations. The alkyd provides adhesion, flexibility, durability, and color retention to automotive and other fast-drying finishes. These alkyds are also baked with urea and melamine resins to give hard, tough coatings for washing machines, refrigerators, home freezers, and other appliances. Such appliance finishes have outstanding gloss and whiteness retention, and resist food stains, detergents, and mild acids and alkalies. Short-oil oxidizing alkyds made with soya or dehydrated castor-oil acids are used in all types of industrial baking finishes. Metal cabinet enamels, automotive enamels, and can coatings are a few of these.

The medium and long-oil alkyds are known widely for their use in many household paints. Using oxidizing oils, these alkyd finishes air-dry to a film of excellent durability and gloss retention. Flat wall paints, enamels, and porch, floor, and deck paints are a few specific examples.

Vinyl resins

Chemistry and manufacture: Vinyl resins are thermoplastic materials made by simple linear polymerization of their monomers. The monomers may be manufactured either from ethylene or acetylene. For example, vinyl chloride may be prepared from the reaction of chlorine on ethylene or hydrogen chloride on ethylene, followed by dehydrochlorination, or hydrogen chloride on acetylene. Likewise, vinyl acetate is obtained from acetylene and acetic acid. The polymerization reactions are usually carried out at moderate temperatures with peroxide catalysts.

Vinyl chloride-acetate and other copolymers are readily prepared from the particular monomers. Polyvinyl alcohol is obtained by hydrolysis of the acetate, and reaction of the alcohol with butyraldehyde yields polyvinyl butyral. Vinylidene chloride monomer is produced by the pyrolysis of trichloroethane or by the treatment of trichloroethane with lime.

Properties and major applications: There are two fundamental ways in which all vinyl resins can be incorporated in coating materials—as solutions or as dispersions. Of the solution coatings, the chloride-acetate copolymers are the most widely used. These resins are applied from ketone solutions to form films of great strength, durability, and abrasion resistance. Chemical resistance is excellent; films are not attacked at normal temperatures by alkalies, mineral acids, alcohols, greases,

oils, or aliphatic hydrocarbons. Permeation by water vapor is extremely low. Higher vinyl chloride content increases chemical and solvent resistance and higher molecular weight increases the abrasion resistance, but these are accomplished with a lowering of solubility, of course.

Baking formulations develop good adhesion to smooth metal. Excellent air-dry adhesion to metal and other difficultly-adhered-to surfaces can be obtained by polymerizing small amounts of other polar groups in the resin. Vinyl copolymer-based coatings are always pigmented for exterior use, and this, coupled with proper additives, provides very good heat and light stabilization. Plasticizers are usually added to increase flexibility or to speed the evaporation of solvents.

One of the chief uses for copolymers has been in linings for beer or soft-drink cans, where they are used as topcoats over phenolic or epoxy primers. Others are marine antifouling paints, masonry coatings, paper milk carton coatings, and maintenance and sanitary enamels.

Polyvinyl butyral forms the basis of the well-known "wash primers." Applied to metal surfaces, wash primers air-dry to provide temporary protection and to serve as a base for the application of topcoats. The most important use of wash primers to date has been in the production of maintenance paints.

Vinyl acetate resins are odorless, tasteless materials with excellent heat-sealability and adhesive properties. They resist weak alkalies, weak acids, and salt solutions. For solution coatings, alcohols and ketones are the usual solvents. Applied from properly formulated solutions, these resins are used for adhesives, in milk cartons, and in paper coatings and leather finishes.

Vinylidene chloride is often copolymerized with acrylonitrile for coating use. The coatings are flexible, strong, and have been found to show outstanding resistance to mineral acids, solvents, and moisture. Applied from ketone solutions, these resins have been used in steel tank linings, pipe linings, maintenance finishes, and in chloride-acetate strippable coatings to provide greater cobwebbing.

In dispersions, the resin, instead of being dissolved in the liquid medium, is suspended in it as very small particles. This overcomes the solubility limitations of vinyls, permitting higher resin solids (60% or more) and the use of the more abrasion- and chemical-resistant grades. Costs are much reduced. Dispersions must be baked after application.

Organosols are vinyl resin dispersions in plasticizer-organic solvent mixtures. They are used as coatings on lawn furniture, office equipment, and on automobile dashboards. Plastisols consist of resin and plasticizer only, and are widely used to coat such consumer items as wire goods and novelties, and many industrial items such as fume ducts, pump impellers, and steel carrying hooks.

A third type of dispersion is polyvinyl acetate latex paint. These coatings dry rapidly by water evaporation to form continuous, tough, non-re-emulsifiable films. They are used widely in interior wall paints, adhesives, and paper and textile finishes.

Acrylates and methacrylates

Chemistry and manufacture: These resins, like the vinyl resins to which they are related, are derivatives of olefinic hydrocarbons. The monomers are prepared by esterifying acrylic or methacrylic acids with alcohols. The monomers may then be polymerized separately, or copolymerized with each other or with other materials such as vinyl chloride.

Properties and major applications: Coating formulations containing these thermoplastic acrylate and methacrylate resins are usually formed from organic solvent solutions or from latices. The methacrylate polymers produce generally harder films with lower flexibility than the acrylate polymers. Also, the methyl esters are generally harder than higher esters such as ethyl or butyl, but are not as flexible. Consequently, methyl methacrylate polymers produce the hardest and most rigid films. Except for the latices, coatings are generally baked and have excellent resistance to water, alcohols, alkalies, acids, oils, and greases. Water-white clarity and excellent light stability permit the use of the full color range, including whites and pastels. Adhesion is enhanced by adding maleic-modified vinyl resins.

Heat-resistant white enamels, fluorescent coatings, cloth coatings, and toilet-seat enamels are a few solution applications. Others are clear coatings for silver, paper, and cloth lampshades, paintings, and raincoats. Decorative and metalized coatings can also be applied to plastic articles.

A newer development is the growing popularity of acrylic latex dispersions for interior and exterior wall paints. These finishes have durability, lack of odor, fast drying speed, and ease of application. They have also been used successfully for coating leather.

Styrene resins

Polystyrene is a polymerization product of vinylbenzene which in turn is derived from ethylene and benzene. Styrene polymerized alone is not too generally used as a coating material because of its brittle nature. Plasticized polystyrene latices, however, have had quite wide use over the last decade in coatings for porous surfaces. Upon drying, these water-base paints form films that have good water and abrasion resistance, acid and alkali resistance, and color retention. Films are nonblocking and have good retention of flexibility on aging and exposure. Polystyrene latices are used in coatings for concrete blocks, wallboard, fresh plaster, paper, leather, and cloth.

Styrene-butadiene copolymers of high styrene content are a very important item in latex paints for interior walls and in clay coatings on paper. As the water content of such coatings dries, the resin particles fuse into tough, elastic films.

Polyethylene resins

Polyethylene resins are essentially long-chain saturated hydrocarbons, and are formed from ethylene by high pressure, temperature, or catalyst. Polyethyl-

ene resins offer an unusual group of properties to the coating field. Abrasion-resistant, flexible, strong, heat-sealable, clear, and light in weight, these resins are practically impervious at ordinary temperatures to mineral acids, strong alkalies, and most nonpolar solvents. Moisture vapor transmission is extremely low.

The most significant coating applications of polyethylene have been in the packaging field, where it has been used in combination with paper, cellophane, foil, boxboard, and others. Hot-solution and hot-melt methods of coating have been used at times for this. The hot-solution technique involves the danger of using hot solvents (at or near their flash point) and hot melting may promote degradation of polyethylene. Thus, in recent years the extrusion coating process has accounted for the lion's share of this market. Extrusion coating is an easy one-step technique that requires no solvents. The resin is hot for short periods only, and the chance of degradation is low.

Of recent commercial significance are white-pigmented polyethylene coatings on boxboard. These materials are being extensively used for packaging bakery products, and undoubtedly will spread to other food products.

Polyethylene-coated paper is being used for multiwall bags; individual packages for food, tobacco, and cosmetics; and photo-sensitive paper. Polyethylene-coated cellophane is excellent for many liquid-containing products such as ketchup, pickles, sauerkraut, suntan oils, and meat. Foil has been made much more suitable and versatile by polyethylene coatings. Cubed beefsteak, instant coffee, dehydrated soup, liquid shampoos, and military protective laminates have used this combination.

Polyethylene resins are being used in increasing quantities to upgrade various different types of paraffin waxes. Milk cartons have been a big market for polyethylene-wax blends. Other uses are for bread wrappers, wax papers, kitchen wraps, and multiwall bags. In short, these blends fit in where an economical coating is desired having properties akin to the unmodified polyethylene materials.

Epoxy resins

Most epoxies used in coatings are condensation polymers of epichlorohydrin and bis-phenol A. By varying the proportion of reactants, a wide range of molecular weights may be obtained. Increasing the amount of epichlorohydrin lowers the molecular weight of the product. The lowest-molecular-weight epoxy resins are viscous liquids, while the highest polymers are hard, brittle solids.

Epoxy resins give outstanding properties to coatings: excellent chemical resistance; excellent flexibility, impact resistance, and abrasion resistance; and superior adhesion to all the commonly coated surfaces. The coatings can be formulated to be resistant to most liquid and gaseous industrial chemicals and products, liquid foodstuffs, and other difficult materials. Only strong mineral acids should be avoided—but fumes and splashes are withstood well.

Epoxy resins may be used in coating formulations three ways. The lower-molecular-weight materials are cured upon application by mixing with reactive materials such as amines or polyamides. The medium - molecular - weight resins are cooked with vegetable-oil acids to form esters, much in the same way as alkyds. Both the amine-cured and esterification-type resins can be formulated for baking or air-drying. The baked resins, naturally, exhibit the better resistance properties, being more fully reacted. In addition, the amine-cured finishes contain a greater proportion of epoxy resin so the epoxy properties are present to a greater degree.

The uses for the amine-cured epoxies are centered where low-temperature conversion, high solids, and high chemical resistance are required. Collapsible tube finishes, electrical insulation varnishes, drum linings, and furniture finishes are important applications. Outside coatings for gas and oil pipelines are an interesting large-volume potential. Tar-epoxy combinations are the latest development in pipes.

Polyamide-cured epoxy resins have been successful on paper and cardboard surfaces, such as boxes, cartons, outdoor signs, and paper book covers.

Markets for epoxy esters include baking coatings for food cans, machine tools, and hardware. Air-dry formulations are used as floor varnishes and as industrial maintenance paints. The highest-molecular-weight resins are used in baking formulations with phenolic, urea, or melamine resins. Having the highest resistance properties of the epoxies, such coatings are found on tank cars and drums, as well as on metal furniture.

References

Consult the Subject Index for additional information concerning coatings. See also the Coatings Chart for information on properties and trade designations. For sources of coatings, see Directory Index, p. 1018.

"Polyamide-epoxy resins," by D. E. Floyd, W. J. Ward, and W. L. Minarik, MODERN PLASTICS *33*, 238 (June 1956).

"Cellulose lacquers," Ind. Eng. Chem. *48*, 1320 (Aug. 1956).

"Mechanism of wash primer action," by L. Kruger and M. C. Bloom, Ind. Eng. Chem. *48*, 1354 (Aug. 1956).

"Glossier paints," Chem. Eng. News *34*, 2697 (May 28, 1956).

"Urethane coatings go down to the wire," Chem. Week *78*, 60 (May 5, 1956).

"Coatings: how to sell a $700-million market," by H. Burrell, Chem. Week *78*, 71 (Mar. 17, 1956).

"New plastic coating for printing finishing," by H. E. Crawford, Jr., Paper Trade J. *140*, 24 (Mar. 26, 1956).

"How new internal coatings are proving their worth," by W. T. Theis, Oil and Gas Journal *54*, 151 (Feb. 13, 1956).

"Preparation and properties of polyurethane coatings," by Reilly and Orchin, Ind. Eng. Chem. *48*, 59 (Jan. 1956).

"Coatings annual review," by H. Burrell, Ind. Eng. Chem. *48*, 28A (Jan. 1956).

"Accelerated tests for mildew resistance of oil paints," by R. M. Evans and E. G. Bobalek, Ind. Eng. Chem. *48*, 122 (Jan. 1956).

Resins for Adhesives

BY R. F. BLOMQUIST*

Development of practical adhesives based on synthetic resins began in this country in the early 1930's with the introduction of urea and phenol resin adhesives for wood and certain other materials. Advances made since that time have been rapid, with much of the stimulation coming from the unusual and often severe requirements for adhesive-bonded components in military uses.

Adhesive bonding

Adhesive bonds offer a number of advantages over mechanical and other methods of fastening:

1) The joining together of certain materials that are difficult or impossible to attach by other methods, e.g., bonding paper labels to cans or bottles.

2) Economical and efficient bonding of small pieces of adherends into larger units, e.g., structural laminated timbers for buildings and naval vessels made up of small pieces of wood bonded together into a large piece.

3) Production of smoother surfaces and contours, e.g., use of adhesives eliminates need for rivets in aerodynamic surfaces in aircraft, and in bonded clutch and brake facings.

4) More efficient and uniform transfer of stresses from one member of the assembly to another, e.g., sandwich panels, prefabricated stressed-cover building panels, adhesive-bonded metal helicopter rotor blades, etc.

5) More efficient design of component parts through better selection of individual components.

6) Less chance of corrosion in joints between dissimilar metals, e.g., adhesive reduces galvanic action caused by direct metal-to-metal contact.

7) Better sealing action for gases and liquids in joints, e.g., assembly of wooden boats with modern water-resistant adhesives.

At the same time, there are certain limitations to adhesive bonding. Authorities are now generally agreed that the actual nature of adhesion is very likely one of specific chemical or physico-chemical attraction of the adhesive for the material bonded. In general, polar adhesives bond best to polar materials, and nonpolar adhesives bond best to nonpolar materials. Thus, to achieve optimum performance, it is necessary to select an adhesive with the proper chemical characteristics.

Joints involving two different adherends are likely to experience particularly significant internal stresses when undergoing changes in temperature or moisture content. Many of these problems of internal stresses may be minimized by modifying the physical properties of the adhesives by judicious incorporation of plasticizers, fillers, etc.

Forms of adhesives

Any adhesive must generally wet the surface to be bonded and must possess a certain amount of flow when bonding pressures are applied, to produce satisfactory bonds. Therefore, most adhesives are used in the liquid form and are generally supplied as liquids, or as solids to be dissolved or dispersed in a solvent at the time of use. Such liquid adhesives may be ready to use as received, or may require the addition of catalysts, fillers, extenders, and other components at the time of use. Tape adhesives are becoming increasingly popular because of their ease of application. These include the pressure-sensitive types that are ready to use, adhesive-coated papers and fabrics to be activated by moistening with water or other solvents, and solid, supported, or unsupported tapes to be cured by hot-pressing.

Types of adhesives

Adhesives may be classified on the basis of the mechanisms by which they harden and develop joint strength, as follows:

Air-drying or solvent-release types: These adhesives are solutions, emulsions, or dispersions of the bonding agent—such as thermoplastic resin or rubber—in water or an organic solvent. In all cases, at least a part of the solvent must be lost from the adhesive film to produce the gelling or hardening by which final bond strength is achieved. The solvent may be lost to the air by open-air drying before the joint is assembled, as with many rubber-base adhesives, or it may be largely transferred into the porous adherends after assembly, as with certain emulsion-type adhesives or water-base adhesives of vegetable gum or starch origin.

Hot-melt or fusible types: Adhesives that can be liquefied sufficiently by melting to produce the necessary flow in bonding are commonly used by the hot-melt process. Such adhesives solidify again upon cooling. Often this is a reversible process, resulting in bonds that are thermally sensitive. Hot-melt adhesives are generally fast-setting and are particularly suitable in such applications as modern high-speed bookbinding and packaging.

Pressure-sensitive types: Such adhesives are characterized by high degrees of initial tackiness so that they bond instantly when slight pressure is momentarily applied to force the two mating surfaces together. Bonds are generally rather low in strength compared to those with other types of adhesives, but their rapid setting under contact pressures makes them extremely attractive, both as liquid adhesives and in the popular pressure-sensitive tapes.

Chemically-reactive types: These adhesives are applied as liquids or as tapes, but are set to an insoluble, infusible state by undergoing a chemical reaction. The rate of this reaction increases

*Chemist, Forest Products Laboratory (maintained at Madison, Wis., in cooperation with the University of Wisconsin), Forest Service, U. S. Dept. of Agriculture.

References were prepared by the editors.

Recent Developments will be found in section on Adhesive Bonding. See p. 818.

as the temperature increases, and may also be controlled by catalysts. Casein glues and certain other adhesives based on natural products may be formulated so that they develop strength and permanence, at least partially, by such chemical reaction. However, most glues of this type are based at present on the various thermosetting resins, and are applied in liquid form. A number of new tape adhesives have recently been introduced, particularly for metal-bonding, which liquefy rapidly when heated in the curing process and subsequently cure by chemical action.

Adhesive materials

Adhesives from materials of natural origin: Many of the earliest adhesives were based on proteins from various natural products. The proteins from hides, sinews, and other animal sources are still widely used as adhesives for wood and paper. They are dispersed in water to form a gel, which is then melted and applied as a hot-melt, or, by protection with suitable gel depressants, cooled again to room temperature for application. Such animal proteins are also used in gummed paper coatings. Casein and soybean proteins are modified with lime and caustic soda to produce important adhesives for wood and paper. Blood proteins are sometimes used alone, but more often with soybean and other proteins, or in combination with thermosetting resins, as plywood adhesives. A practical blood adhesive for room-temperature pressing of interior-type softwood plywood has recently been announced. Carbohydrates such as starches and dextrines are dissolved in water and used primarily as paper adhesives, either in liquid form or as gummed coatings. Other important adhesives based on asphalt are used as mastics in emulsion or solution form to bond flooring tiles to subfloors. Low-cost adhesives based on sulfite paper-mill residues are still used as linoleum cements.

In general, adhesives based on naturally-occurring materials have good dry strength, good permanence under mild conditions, and satisfactory handling properties for many applications. However, they have moderate-to-low resistance to water and high relative humidities. Some improvements in these latter properties can be obtained by incorporation of tanning agents for the proteins or of fungicides to reduce the accompanying biological attack. Such benefits are generally only of limited value for the more severe exposure conditions.

Urea-formaldehyde: These resins enjoy wide popularity, particularly in the wood industries, because of their versatility, light color, and relatively low cost. The basic resins may be formulated with the proper catalysts for pressing either at normal shop temperatures or with added heat. Glue lines may be heated for faster curing by hot platens, heated chambers, or with high frequency. Their widest use is in bonding hardwood plywood for furniture, doors, and other architectural uses. Another important use is in edge-gluing lumber for furniture.

Urea resin adhesive joints are strong when either dry or wet, and have good permanence under mild conditions. However, resistance to continuous or intermittent heat or high humidity will reduce joint strengths significantly. Glue-line costs in plywood made with these adhesives may be reduced by incorporation of wheat flour or other cereal flour extenders, although at some sacrifice in moisture and water resistance. Permanence of the straight urea resin joints may be increased by incorporation of melamine resins or resorcinol. Special formulations are offered for use where thick glues must be tolerated.

Phenol-formaldehyde: These resins are used principally in adhesives for exterior-type softwood plywood, in which bonds (properly made) are more durable than the wood itself, under exterior and other severe service conditions. Thin paper impregnated with a phenol resin is used as a film glue, especially for bonding together very thin, fragile veneers that would be difficult to spread with liquid adhesives.

Phenol resin adhesives are commonly pressed and cured at 270° F. or higher. Attempts to develop practical room-temperature-setting phenol resin adhesives by use of highly acid catalysts have been only moderately successful, because in some cases the strong acids required have damaged wood and other cellulosic fibers being bonded.

Phenol resins are also used for bonding rock wool or glass fibers in roll- or batt-type thermal insulation. They are important components, when modified with thermoplastic resins or synthetic rubbers, in metal-bonding adhesives in aircraft, and for bonding copper or silver foils to insulating plastics laminate backings in the production of printed circuits for electronic equipment. In these applications the adhesive bond must resist the subsequent etching and soldering operations.

Melamine-formaldehyde: Adhesives based on these resins combine the high durability of the phenol resins with the light color of the urea resins. Such adhesives are normally cured at 240° F. or higher. Attempts to reduce the curing temperature of these adhesives have not been promising. At present, melamine resins are used primarily in combinations with urea resins to produce adhesives for hardwood plywood that will meet the standard boil-cycle tests and be suitable for use under the more severe service conditions where straight urea resins are inadequate. Such melamine-urea resins are cured at 240° F. or higher, and tend to approach the high durability of straight melamine resins as the proportion of melamine resin increases.

Resorcinol: Adhesives based on resorcinol resins combine the room-temperature-curing properties of the urea resins with the high permanence of the phenol and melamine resins. They are currently important for laminating wood members for boats and for other exterior uses, such as bridge timbers and utility-pole cross-arms. For gluing strong, high-density species, curing at an elevated temperature may be required. Their relatively high cost has limited their wider use.

New formulations of copoly-

merized phenol-resorcinol resins have reduced the cost of these adhesives somewhat, but further reductions are desirable for wider application, as in prefabricated house panels and laminated barn rafters. Resorcinol resin adhesives are reported to bond well to rubbers and to certain plastics, such as laminates of phenol or melamine resins. Resorcinol resins are also used for coating or priming rayon and nylon tire cords to produce better bonding of the rubber and cords in tire production.

Epoxies: Originally these resins were condensation products of epichlorohydrin with some hydroxy compound, the most typical being bisphenol. The linear polymers produced were then converted into thermoset polymers by cross-linkage with certain reactive groups on the chains by means of carboxylic acid or amine curing agents. Adhesive formulations have thus been developed with either room-temperature-setting properties or the ability to cure at temperatures of 200 to 390° F. Since some resins are liquids and others can be dissolved in reactive solvents, such as allyl glycidyl ether, it is possible to formulate 100% reactive liquid systems for easy application and bonding under contact pressures.

Epoxy resin adhesives will bond remarkably well to a variety of different adherends, including plastics, wood, metals, and glass. These properties recommend their use in the aircraft industry for bonding metal skins to metal or glass-fabric honeycomb cores. Recent requirements for greater degrees of heat resistance for adhesives in aircraft and missiles have stimulated further research on development of new epoxy resins that are based on hydroxy compounds other than bisphenol, on the search for more effective curing agents, and on combinations of epoxy resins with other materials, such as phenol resins.

Vinyls: Vinyl resins, in either solution or emulsion form, have found wide acceptance in bonding applications. Of greatest interest are emulsions of polyvinyl acetate or of copolymers of this resin and other resins. These emulsion adhesives were originally used for bonding paper, for carton sealing, and for similar applications. They have since been reformulated for wood gluing. In the latter use, they are proving suitable particularly for assembly of furniture and cabinet work. Earlier limitations of low moisture and temperature resistance, and of creep and cold flow under sustained stresses have been partially overcome. Recent modifications of polyvinyl resin emulsions with phenol or urea resins have reduced some of these limitations without sacrificing the advantages these emulsion adhesives possess in ease of use and speed of setting.

Cellulosic derivatives: Cellulose esters, particularly cellulose acetate and cellulose nitrate, have long been used in solvent dispersions as household cements. They bond well to paper, and to certain plastics, wood, and leather. They are often used as adhesives in shoe manufacturing.

Acrylates: Polymers of methyl methacrylate and ethyl acrylate are often used as adhesives for plastics, paper, and other materials, where a tough, transparent, flexible film may be required. In some cases the monomer may be used as the adhesive to be polymerized in the joint. Recently, special acrylate resin formulations have been developed for metal-bonding applications.

Polyesters: Esters of maleic and phthalic acids with polyhydroxy compounds (such as glycols) are used as adhesives, or as ingredients in pressure-sensitive adhesive compositions. Unsaturated polyesters, like those of maleic acid and glycols, are used as adhesives for bonding fibrous glass-polyester laminates to themselves.

Isocyanates: Polyurethane derivatives of polyester resins and certain diisocyanates have recently been used to formulate special adhesives for polyurethane elastomers (or foams) and for bonding rubber. These new resins offer interesting bonding properties for several materials.

Elastomers: Both natural and synthetic rubbers are widely used as adhesives, mainly as solutions in certain organic solvents. Such adhesives may vary from simple solvent-release adhesives for bonding paper and similar materials at room temperature, where only light bond strength is required, to special thermosetting formulations for heat-curing with special vulcanizing agents. Such rubber-base adhesives are widely used in the fabrication of rubber goods, including tires, for bonding rubber to other materials, such as metals, or for the repair of rubber articles, such as tires and tubes. Recently, neoprene-base cements in organic solvents have been adapted for field application of plastic laminates to plywood (or other bases) for counters and tabletops. These cements are also used in fast, continuous processes for bonding such materials in commercial production, using infrared drying and pinch rollers for applying pressure. This latter process is also being used for industrial bonding of ceramic-coated and other metal surfaces to backings of hardboards or to various of the core materials used in building panels. Similar rubber cements have been adapted for bonding thin wood floor strips and tiles to concrete and other subfloors. Some rubber latices are also used as adhesives.

Combinations of resins

Probably the most important recent developments in adhesives have been those in which two or more basic resin components are combined to produce adhesives with superior properties. Early examples were the casein-rubber latex formulations used for bonding metal facings to plywood. These adhesives are still in use at the present time.

More recently, melamine resins have been added to urea resin adhesives to improve the permanence of the resultant joints. Phenol resins have been combined with resorcinol resin adhesives to reduce the cost without undesirable sacrifices in joint quality or ease of use at lower curing temperatures. Thermoplastic resins, such as polyvinyl acetate or butyral and acrylonitrile-butadiene, or neoprene rubbers, have been combined with phenol res-

ins to produce more adequate structural metal-bonding adhesives. Combinations of phenol and epoxy resins are a recent innovation to produce structural adhesives for use in aircraft where service temperatures above 400° F. are required. One such adhesive in tape form has recently been introduced for use in high-speed jet aircraft. Much additional research is currently in progress to develop better heat-resistant adhesives for such requirements.

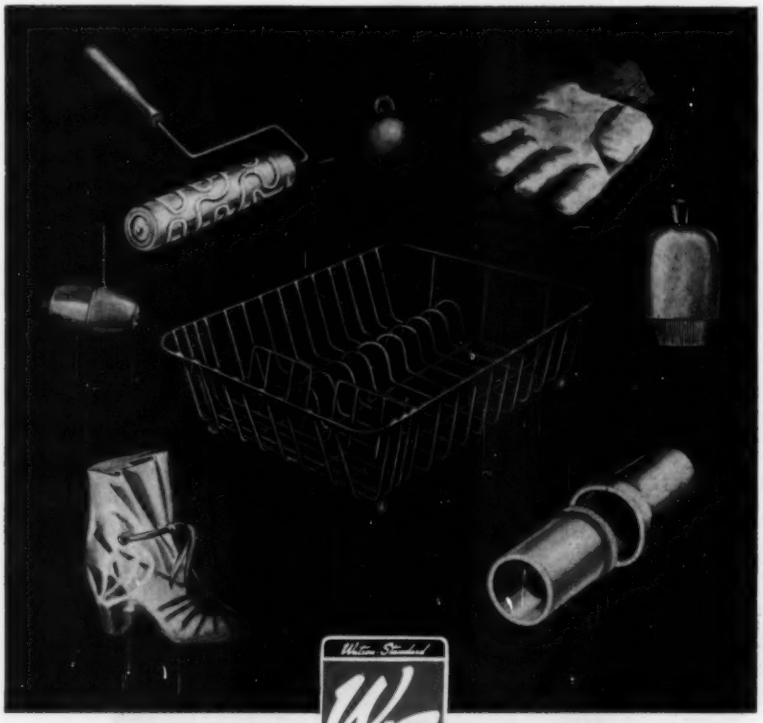
Other adhesive components

Solvents: Except for the tape or film adhesives and those applied in molten form, all adhesives must be applied in a liquid form, usually from solution of the components. In most large-scale operations, such as in the paper- and wood-bonding fields, water is the most common solvent. It excels organic solvents in low cost and in freedom from fire and safety hazards. Clean-up of equipment is also much simpler with water-base adhesives. On the other hand, many metal-bonding adhesives are soluble only in organic solvents. The actual solvent composition may be quite complex, particularly for spray application. The solvents (and other diluents and thinners) must be selected with care, not only to produce the desired solution of suitable consistency for application, but also to avoid objectionable changes in viscosity of the adhesive when operating on mechanical roll spreaders during the life of the adhesive, or to avoid any objectionable "cob-webbing" when sprayed. Solvent systems must also be selected to: 1) produce only the desired degree of penetration (or wetting of the surfaces) without any excessive bleeding or strike through, and 2) to result in the desired reactivity of the film at the time the joint is assembled and pressed. With certain resin adhesive systems in solution in rather complex organic solvents, the film surface often "skins over" before adequate loss of solvent occurs. This often results in excessive blisters and blow-ups, particularly with hot-setting formulations, and may require long air-

Watson-Standard

Best known name in

PLASTISOL



Plastisols are versatile. Watson-Standard Laboratories formulate plastisols of special characteristics for a wide variety of end uses. If your product requires a soft plastic coating or molded part you should consider the use of versatile vinyl plastisols. They are adaptable to many methods of application —Spraying, dipping, casting, rotational molding, spread coating, roller-coating, troweling, slush molding.

Watson-Standard Co.

225 Galveston Ave. Pittsburgh 30, Pa.

PLASTICS • INDUSTRIAL FINISHES • CHEMICALS

ACME

DIALLYL PHTHALATE MOLDING COMPOUNDS

superior dielectric materials

- Developed specifically for electrical and electronic components.
- Used as component dielectrics or molded parts in aircraft, automobiles, missiles and communication equipment.
- Combine the prime qualities of high arc-, insulation- and moisture-resistance.
- Resistant to heat, acids, alkali and fungus.
- Superior dimensional stability for many critical mechanical applications where the electrical properties are secondary.
- Available in varied formulas.

There are combinations available in Asbestos, Dacron, Orlon as well as high and medium impact glass-filled material. Many colors available on special order.

Flame retardant molding compounds available and approved by Underwriters Laboratories.



INQUIRIES *are invited for variations on the standard Diallyl Phthalate Molding Compounds. Acme will be happy to work with interested companies on their particular molding requirements.*

ACME RESIN CORPORATION
1401 CIRCLE AVENUE • FOREST PARK, ILLINOIS
(Suburb of Chicago)

drying or precuring at elevated temperatures before actual curing.

Catalysts and curing agents: Modern adhesives based on thermosetting resins develop their strength and permanence by undergoing chemical reactions, the rates of which are dependent on catalysts as well as upon the temperature of the adhesive film. Catalysts may be introduced in the resins or may be added at the time of use. New catalyst systems are continually being developed to provide the best compromises between fast-setting, reasonable pot life, and greatest freedom from undesirable effects on the adhesive or adherend in use. For some years special urea resin systems have been used in certain woodworking operations where fast setting at room temperature is desired and where sufficient catalyst could not be added in the glue mix without excessively reducing the pot life. Here the reactive catalyst is applied to one mating surface and the resin to the other, so that rapid mixing occurs upon assembly and application of pressure. Recently, special automatic metering equipment has been developed to mix epoxy resins and curing agents at the point of application. This equipment permits the use of a very reactive resin system without creating a prohibitively short pot life.

Some resin systems are so reactive that part of the actual reactant must be withheld in the original resin preparation and then added at the time of use. Such components, added in stoichiometric proportions, instead of smaller catalytic amounts, are referred to as curing agents, or hardeners. A good example is the additional formaldehyde added as paraformaldehyde or hexamethylenetetramine to combine with novolak-type phenol and resorcinol resins, or the amine curing agents used to cross-link epoxies.

Fillers and extenders: Materials added to adhesives primarily to improve certain handling properties or performance are referred to as fillers. Walnut or pecan shell flour fillers are commonly incorporated in urea-, resorcinol-, and phenol-resin

woodworking glues to improve consistency for better spreading, and to reduce penetration on the more porous woods. Metals and minerals may be used as fillers in epoxy resin adhesives to improve mechanical properties and to alter the thermal expansion coefficients to approximate more closely those of the metal adherends. Extenders are added primarily to reduce the cost of the adhesive. Examples are wheat and other cereal flour extenders for urea resin plywood adhesives.

References

Consult the Subject Index for additional information concerning adhesives. See also the Adhesives Chart for information on properties and trade designations. For sources of various types of adhesives, see Directory Index, p. 1018.

"Climbing peel test for strength of adhesive bonds," by F. Werren and H. W. Eickner, MODERN PLASTICS *34*, 187 (Dec. 1956).

"Metal-bonding adhesives for high-temperature service," by J. M. Black and R. F. Blomquist, MODERN PLASTICS *33*, 225 (June 1956).

"Choosing adhesives for plastics," by I. Skeist, MODERN PLASTICS *33*, 121 (May 1956).

"Room-temperature bonding," by J. L. Been, MODERN PLASTICS *33*, 126 (Mar. 1956).

"Clock viscometer measures pot life," MODERN PLASTICS *33*, 133 (Mar. 1956).

"Epoxy-base adhesives in the aircraft industry," by W. Bandaruk, SPE J. *12*, 20 (Aug. 1956).

"Some chemical aspects of urea-formaldehyde wood adhesives," by J. A. Ross, Plastics Inst. Trans. and J. *24*, 278 (July 1956).

"The adhesive properties of epoxy resins," by N. A. deBruyne, J. Applied Chem. *6*, 303 (July 1956).

"High-strength adhesives for metal-bonding," by R. F. Blomquist, Machine Design *28*, 99 (May 31, 1956).

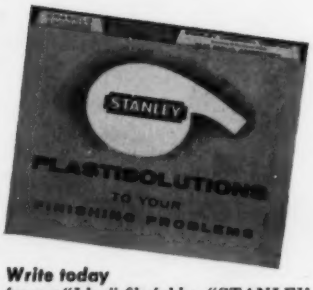
"How high temperatures affect epoxy adhesives," by E. W. McGuiness, Materials and Methods *43*, 120 (Mar. 1956).

"Adhesive-bonding of metals," by S. N. Muchnick, Mech. Eng. *78*, 19 (1956).



The name on the drum—STANLEY*—has earned a great reputation. The drum contents help maintain that reputation. That's why, when special jobs create special finishing or molding problems, more and more manufacturers are looking to these drums for the *right* solution . . . *custom formulated* vinyl dispersions (*both* Plastisols and Organosols) that meet specific requirements.

Solving finishing and molding problems is our business . . . and has been for many years. Let us have *your* questions. We'll give you the answers.



Write today
for our "Idea" file folder, "STANLEY PLASTISOLUTIONS TO YOUR FINISHING PROBLEMS" to . . .

STANLEY CHEMICAL COMPANY*
Subsidiary of The Stanley Works
DEPT. I., 1438 BERLIN STREET, EAST BERLIN, CONNECTICUT
**Member, Vinyl Dispersions Division, S.P.I.*

STANLEY

See STANLEY first for finishes that last
LACQUERS • SYNTHETICS
VINYLS • ENAMELS

STANLEY TOOLS • STANLEY HARDWARE • STANLEY ELECTRIC TOOLS
STANLEY-JUDD DRAPERY HARDWARE • STANLEY STEEL STRAPPING

PETROTHENE®

POLYETHYLENE RESINS

for { EXTRUSION—FILM • PIPE • PAPER COATING • WIRE COATING
MOLDING—INJECTION • COMPRESSION • BLOW MOLDING

PETROTHENE® POLYETHYLENE RESINS

PETROTHENE® TYPE	MELT INDEX	DENSITY	FILM	INJECTION MOLDING	EXTRUSION LAMINATION	MISC.
100	2	0.917	Heavy Gauge 1½ mil and up	Good stress crack resistance	Heavy Gauge	Blow Molding
200	3	0.916	Medium Gauge 1 mil and up Excellent impact	—	—	—
201	5	0.916	Medium Gauge ¾ mil and up Very good impact	Small 6-10 oz.	Good uniformity Good extrusion characteristics	Blow Molding
202	22	0.914	—	Very large 20 oz. (Excellent low temperature impact strength)	—	—
203	8	0.915	Thin Gauge ⅓ mil and up Good Clarity Good impact	Large 10-20 oz. Good stress crack resistance	Good production rates Thin Gauge	—
204	3	0.916	Low Clarity Medium Gauge Excellent impact non-blocking	—	—	—
205	3	0.924	Medium Gauge 1 mil and up	Very small 6 oz.	—	Blow Molding
206	5	0.924	Lay Flat Thin Gauge ½ mil and up	Small 6-10 oz.	Good melt stiffness Excellent extrusion characteristics	Blow Molding
207	8	0.924	Superior Clarity and Gloss. Thin Gauge ⅓ mil and up	Large 10-20 oz.	Good production rates	—
208	22	0.924	—	Very large 20 oz.	—	—
201-210	5	0.917*	Mulch film	—	—	Compounded black resin for flat and blown film extrusion.
360	2	0.917*	—	—	—	Compounded black resin for pipe extrusion meeting NSF and CS 197-57 Requirements.
101-216	2	0.923*	—	—	—	Black compounded resin for pipe extrusion having excellent resistance to environmental stress cracking

* *Base Resin Density*

PETROTHENE® 300 SERIES—ELECTRICAL AND WIRE AND CABLE GRADES

PETROTHENE® TYPE	MELT INDEX	COLOR	ADDITIVES
300-6	0.3	Natural	Colorless Non-exuding Antioxidant
300-200	0.3	Black	Colorless Non-exuding Antioxidant plus channel carbon black
300	0.3	Various	Colorless Non-exuding Antioxidant plus colorants
301-6	1.0	Natural	Colorless Non-exuding Antioxidant
301-200	1.0	Black	Colorless Non-exuding Antioxidant plus channel carbon black
301-202	1.0	Black	Colorless Non-exuding Antioxidant plus 0.5% channel carbon black
301	1.0	Various	Colorless Non-exuding Antioxidant plus colorants
302-6	2.8	Natural	Colorless Non-exuding Antioxidant
302-506	3.0	Brown	Colorless Non-exuding Antioxidant plus colorants

FORM: Solid cubes approximately ⅛ inch on a side.

PACKAGING: Polyethylene coated multiwall bags — net weight 50.0 lbs. also, 1500 lbs. and 9000 lbs. U. S. Rubber Sealdbins, for direct shipment from our plant in Tuscola, Ill. Palletized shipments upon request.

COLOR: ALL PETROTHENE types are available in various colors as well as natural.

FREIGHT CLASSIFICATION: By rail — Synthetic Resin, NOIBN
By truck — Plastic Material, Granules
By Express — Synthetic Resins

YOU AND U.S.I.—A PROFITABLE PARTNERSHIP

Here are some of the reasons why you'll find it good business to do business with U.S.I.—

If you mold or extrude polyethylene, you'll find it good business to do business with U.S.I. Here are some of the reasons why: —

A TYPE FOR EVERY NEED — The PETROTHENE compositions now available permit you to make almost any polyethylene item you can sell. "Custom-tailored" compositions can be supplied to meet special requirements.

UNIFORM QUALITY — Precise quality control from natural gas to packaged resin saves processing time: for a given composition, machine settings can remain unchanged through shipment after shipment of resin.

GUARANTEED SUPPLY — Big production facilities located astride a major pipeline insure uninterrupted supply. U.S.I. is the third largest producer of polyethylene today — and is still growing.

FAST DELIVERY — A nationwide sales organization and warehouses in major markets from coast to coast speed delivery of your shipment, whether it be large or small.

TECHNICAL SERVICE — U.S.I. technical service specialists combine thorough knowledge of polyethylene properties with broad experience in processing techniques. They can help you select the right PETROTHENE resin and determine the proper operating conditions for your product and process.

LITERATURE — "Polyethylene Processing Tips", a continuing series of ads in leading plastics magazines, discusses new resin developments and processing techniques. Use the coupon below to make sure you receive each of these informative ads as it appears.

THERE'S A U.S.I. SALES OFFICE NEAR YOU

ATLANTA, GEORGIA	Poplar 6-8039	2713 Springdale Road East Point
BALTIMORE 3, MARYLAND	Lexington 9-0300	1555 Mathieson Building Light and Baltimore Streets
BOSTON 14, MASS.	Capitol 7-8140	160 Washington Street N.
BUFFALO 4, NEW YORK	Summer 4575	301 East North Street
CHICAGO 5, ILLINOIS	Wabash 2-1650	624 S. Michigan Avenue
CINCINNATI 16, OHIO	Valley 4280	120 78th Street
CLEVELAND 13, OHIO	Cherry 1-0073	Rockefeller Building
DETROIT 16, MICHIGAN	Woodward 1-4220	1448 Wabash Avenue
KANSAS CITY 6, MISSOURI	Victor 2-2413	903 McGee Street Pickwick Building
LOS ANGELES 15, CALIF.	Richmond 9-7706	714 West Olympic Boulevard
LOUISVILLE 1, KENTUCKY	Melrose 6-2511	7th and Bernheim Lane P. O. Box 665
MINNEAPOLIS 14, MINN.	Federal 2-7311	2429 University Avenue S.E.
NEW ORLEANS 6, LA.	Canal 0521	708-709 Maritime Building
NEW YORK 17, NEW YORK	Oxford 7-0700	420 Lexington Avenue
PHILADELPHIA 9, PENNA.	Pennypacker 5-5542	123 South Broad Street
ST. LOUIS 3, MISSOURI	Garfield 1-5141	1600 Clark Avenue

U.S.I. INDUSTRIAL CHEMICALS CO.

Division of National Distillers and Chemical Corporation
99 Park Avenue, New York 16, N. Y.
Branches in principal cities

Please put me on your mailing list to receive literature on PETROTHENE® polyethylene resins.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

☐ **Molder:**
- ☐ injection
- ☐ compression
- ☐ other

☐ **Extruder:**
- ☐ film
- ☐ paper coating
- ☐ wire coating
- ☐ other

☐ **Other**

How industry profits from

A Complete Line of Molding Powders . . .



a. GENERAL PURPOSE

Outstanding among general-purpose molding powders are the new G-E 12920 (black) and G-E 12921 (brown). Both offer fast cure, high finish, wide flow range. Mold wear is exceptionally low. Both are suitable for preheated pill and cold powder applications.

b. HEAT RESISTANT

Newest additions to the G-E family of heat resistant molding powders are G-E 12980 and G-E 12981. Both feature low gravity, good dimensional stability, fast preheat and fast cure. With a heat resistance of 500°F and a satin-smooth finish, G-E 12980 is especially recommended for high-performance molded appliance parts. The higher strength and 400°F heat resistance of G-E 12981 are ideally suited to many industrial applications.

c. IMPACT RESISTANT

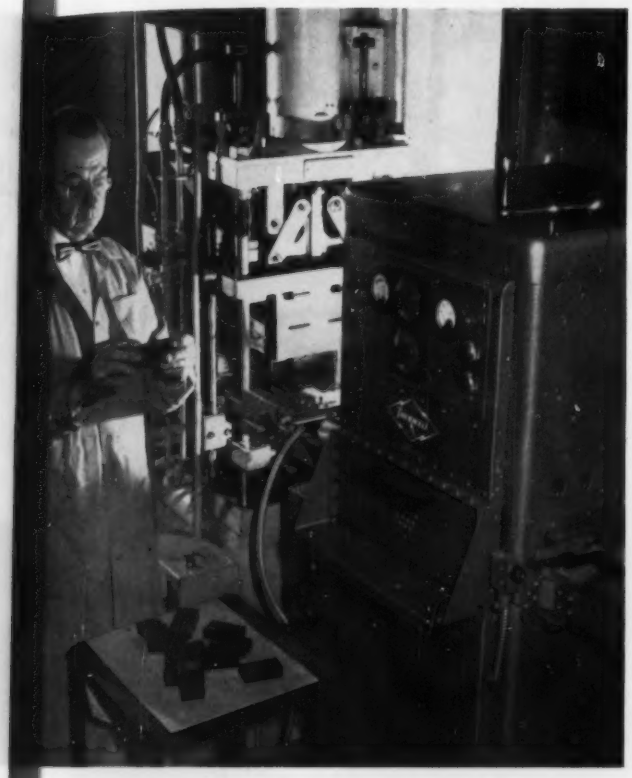
The excellent preform and fast-cure characteristics of the improved impact black G-E 12906 molding powder permit high production cycles and uniform pill weights. Suitable for use on automatic molding machines. Pours fast, preheats fast, takes exceptionally high preheat temperatures without signs of burning. Unsurpassed by any known conventional impact material on the market today.

d. SPECIAL PURPOSE

Indicative of special purpose materials designed to do specific jobs exceptionally well are molding powders for automatic molding, automotive ignition applications and components for electrical apparatus.

G-E progress in phenolics

A Complete Service Program



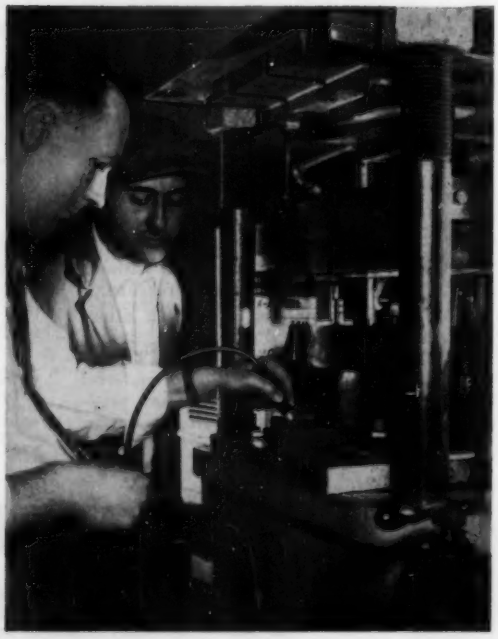
in the laboratory, G-E research is developing new phenolic molding materials to open up new business opportunities for plastic molders. Here, test parts of improved automatic grade phenolics are being molded for subsequent evaluation.

General Electric's two-stage program is designed to yield a better product and earn a bigger profit for the molder and end-user alike.

Stage One is centered in the G-E laboratories. Here continuous and intensive research develops new phenolic molding materials, new applications, new processing techniques. Thus G-E research helps industry meet today's—and tomorrow's—exacting demands in molded phenolics.

G-E technical service comprises Stage Two. Teams of experts in phenolics are constantly at work in the field and in the laboratory to help the molder and the end-user solve their problems. Their objective is to make your business more profitable by helping you design the part and apply the right molding powder for each job.

Put the G-E program to work in your business—soon. For complete product and service information, write General Electric Company, Section MPE-1, Chemical Materials Department, Pittsfield, Mass.



in the field a G-E technical service specialist helps a molder make initial tests on G-E 12980, new heat-resistant molding powder for appliance parts.

Progress In Phenolics

GENERAL ELECTRIC



From colorful and durable panels for delivery trucks to handsome television cabinets...

Pittsburgh Selectron POLYESTER RESINS



Now Ready For A Thousand New Uses!

Just a few products in which Pittsburgh SELECTRON Resins are now used—

Aircraft structural parts
Radomes for electronic equipment
Life floats
Ballistic panels
Helmets
Boat hulls
Machinery housing and guards
Trays
Tote boxes
Food lockers
Garbage pails
Baskets for automatic dishwashers
Baskets for automatic washers
Wash tubs
Tool chests
Shipping containers
Instrument cases
Laundry hampers
Kitchen containers
Fishing rods
Sinks
Street signs
Traffic signs
Fluorescent light fixtures
Television cabinets
Loudspeaker housings
Gas meter housings
Structural panels for offices and homes
Door and transom lights
Awnings and canopies
Greenhouse panels
Skylighting
Molded chairs
Prefabricated houses and garages
Truck bodies

COUNTLESS products benefit from the combination of beauty and durability Pittsburgh SELECTRON Polyester Resins can give—and usually at reduced manufacturing costs.

SELECTRON Resins are used in products ranging from truck panels that withstand extreme hot and cold, rain, snow, and sleet to television cabinets that serve as focal points of beauty in homes everywhere.

SELECTRON Resins are thermo-setting polyesters which are available in consistency from a thin syrup to extremely high viscosity. They polymerize to form solids, with or without heat and with or without pressure.

When combined with such fillers as fiber glass, cotton, rayon, nylon, felt, sisal, paper, etc., SELECTRON Resins provide a new kind of material that is lighter than aluminum, yet—weight for weight—is stronger than steel. This material has great impact resistance and withstands the deteriorating influence of weather, sunlight, heat, abrasion and many chemicals. It can be molded in durable colors.

Parts in which SELECTRON Resins are used can be molded either by hand lay-up, direct molding, continuous lamination or pre-forming. These resins can also be used without fillers for casting, potting and impregnating.

Investigate the advantages of SELECTRON Resins that may make your products better looking, stronger and more durable. We'll be glad to have one of our engineers discuss your problems with you without cost or obligation. Such a visit may point the way to important production economies and added sales appeal.

SEND FOR FREE BOOKLET

● Write, wire or phone today for our new booklet containing description of SELECTRON Polyester Resins and explaining many of the ways in which they can be used. Pittsburgh Plate Glass Company, SELECTRON Products Division, Gateway Center, Pittsburgh, Pa.

PITTSBURGH Selectron PG

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN PITTSBURGH INDUSTRIES LIMITED

Naugatuck Plastics

Condensed Catalog

1957-1958

Resin Guide

Naugatuck Resin	AVAILABLE FORMS	CHARACTERISTICS OF FINISHED PARTS		
		PHYSICAL	CHEMICAL	ELECTRICAL
KRALASTIC® Resin-Rubber Compounds (Thermoplastic)	Granular, rubber-plasticized resins for: Injection Extrusion	Tough, hard and rigid Dimensionally stable over a wide temperature range High impact resistance Easily machined Can be solvent-welded Light in weight Wide range of opaque colors	Highly resistant to acids, alkalies and other chemicals	Very good dielectric qualities
VIBRIN® Polyester Resins (Thermosetting)	Liquid resins for impregnating glass or other reintorcing fibers for molding by: Pressure or vacuum bag Hand lay-up Molding compounds for matched metal die molding	Strong and tough Good surface hardness Adaptable to very large parts Dimensional stability High heat resistance Unlimited color range; translucent or opaque	Highly resistant to most solvents, acids, bases and salts Low water absorption Good weathering and aging qualities	Good dielectric properties at all commercial frequencies
MARVINOL® Polyvinyl Chloride Resins (Thermoplastic)	White, odorless, tasteless nonhydroscopic powder resins to form compounds for: Molding Extrusion Calendering Dispersion types for: Slush molding Dipping Spraying Coating Rotational molding	May be compounded, plasticized or unplasticized, to give the following properties: Unlimited color possibilities either transparent or opaque Weather resistant Abrasion resistant Strong and tough Non-flammable	Highly resistant to acids, alkalies, alcohol Unplasticized resins are resistant to aliphatic hydrocarbons	Have excellent dielectric properties Can be compounded to meet U.L. requirements

United States Rubber

Naugatuck Chemical Division, NAUGATUCK, CONNECTICUT

Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

NAUGATUCK Kralastic

RESIN-RUBBER COMPOUNDS

KRALASTIC molding and extruding compounds are unique combinations of thermoplastic resins and nitrile rubber. The result is an almost indestructible end product of exceptional strength, toughness and impact resistance.

Extruded as plastic pipe, Kralastic has proved phenominally successful and durable in transporting salt water and sour crude in the oil fields; carrying natural gas, drinking water, corrosive chemicals, irrigating [illegible] and as money-saving, quickly-installed electrical conduit.

The new Kralastic HTHT (high temperature, high tensile) compound now extends the usefulness of thermoplastic pipe.

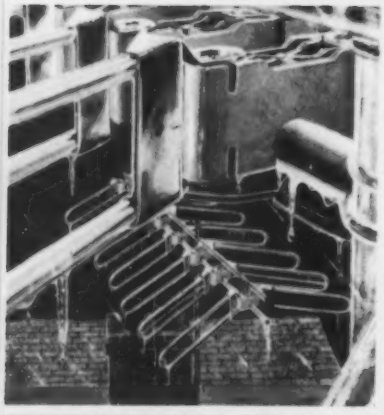
Other Kralastic compounds are under development to meet special needs and may be ready for commercial use by the time you read this. We suggest you consult us regarding your specific requirements. Also write for a reprint of a recent article giving the results of independently conducted weathering tests in which Kralastic pipe proved its superiority over other plastic pipes.



More than 6,000 miles of Kralastic pipe for all purposes were in service by mid-1957. Kralastic pipe now has NSF approval for drinking water service.



All wheels and part of the housing of this mower are Kralastic. The drive wheels have internal gear teeth molded into them.



This TV antenna takes advantage of Kralastic's excellent electrical, physical and weathering properties in its molded Kralastic brackets.



More than 25 million hair combs have been made of Kralastic. One manufacturer guarantees every Kralastic comb against tooth breakage for one year.

PROPERTY	UNIT
Specific Gravity (Natural Color)	
Refractive Index	
Impact Strength	
Izod Notched, 73° F	ft. lbs./in. notch
Izod Notched, 32° F	ft. lbs./in. notch
Izod Notched, 0° F	ft. lbs./in. notch
Izod Notched, —40° F	ft. lbs./in. notch
Charpy Unnotched, 73° F	ft. lbs./in.
Compressive Strength	psi
Compressive Modulus	psi
Flexural Strength	psi
Flexural Modulus	psi
Tensile Strength	psi
Hardness, Rockwell	R scale
Hardness, Shore Durometer	D scale
Thermal Coefficient of Expansion	in./in./° F
Thermal Conductivity	B.T.U./hr/ft.^{2} per ° F/in.
Specific Heat	B.T.U./lb./° F
Heat Distortion, 264 psi	° F
Water Absorption, 24 hrs.	% gained
Compression Ratio (Bulk Factor)	
Flow or Mobility Range	° F
Compression Molding	
Temperature	° F
Pressure	psi
Injection Molding	
Temperature	° F
Pressure	psi
Mold Shrinkage (Average)	in./in.
Extruding Temperature	° F
Calendering Temperature	° F

Distinctive Properties:

- High impact resistance
- Extreme toughness and hardness
- Light weight: 1/2 weight of aluminum; 1/7 weight of iron
- Non-corrosive, non-electrolytic
- Readily sawed, drilled, threaded
- Quickly solvent-welded
- Dimensionally stable over a wide temperature range
- Opaque built-in colors

Major Uses:

- Pipe and pipe fittings
- Light wheels, gears and pulleys
- Durable hair combs
- Machine housings and parts
- Textile warp tubes and bobbins
- Radio and camera cases
- Football and safety helmets
- Tote boxes
- Hose nozzles and fertilizer injectors

ASTM TEST METHOD	KRALASTIC B	KRALASTIC D	KRALASTIC F	KRALASTIC J	KRALASTIC L	KRALASTIC M	KRALASTIC HTHT
	1.06	1.05	1.04	1.02	1.035	1.05 (natural)	1.08 (black)
D542-50	opaque	opaque	opaque	opaque	opaque	opaque	opaque
D256-56	5-9	0.4-1.3	3-6	6-9	5-7	5-7	4-5
	1.8	0.4	1.5	5-6	3-5	—	2.0-2.5
	—	—	—	—	3	1.0	1.0
	0.6	0.4	0.4	1-3	1.5-2.5	.4	—
D256-56	35-51	23-33	28-42	25-35*	30-40**	40-50	30-50
D695-54	6,400	9,000	5,800	4,000	5600	—	—
D695-54	290,000	430,000	280,000	190,000	200,000	—	—
D790-49T	8,000	11,500	7,500	4,000	6,000-7,000	7,500	12,000
D790-49T	260,000	390,000	250,000	170,000	2.5-3.0	220,000	400,000
D638-52T	5,500	6,500	5,000	3,000	3,800-4,500	5,000	8,000
D785-51	96	108	92	62	85-90	86	110
	78	83	78	66	78	—	—
D696-44	5.6×10^{-5}	4.7×10^{-5}	5.6×10^{-5}	7.3×10^{-5}	4.77×10^{-5}	—	—
C177-45	1.0	1.0	1.0	1.0	2.27		
	0.35	0.35	0.35	0.35	—	—	—
D648-45T	187	193	185	172	170-180	175	215
D570-54T	0.3	0.2	0.2	0.2	0.15	—	.3
D392-38	2.29	2.25	2.27	2.27			
D569-48	306	280	280	280			
	325-375	325-375	325-375	325-375	325-375		
	1000+	1000+	1000+	1000+	1000+		
	375-600	350-600	350-600	350-600	325-600		
	6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000	6000-30,000		
	.004-.005	.004-.005	.004-.005	.004-.005	.003-.004		
	400-450	350-375	350-375	350-375	350-450		
	350-400	325-400	325-400	300-375	325-400		

*@32° F = 25-30; @ −30° F = 30-40; @ −40° F = 35-40 **@32° F = 30-40; @ −30° F = 30-40; @ −40° F = 30-40

NAUGATUCK Vibrin

LIQUID POLYESTER RESINS

With the aid of a catalyst, these unsaturated liquid polyester resins are rapidly converted to solids with little or no heat or pressure other than the exothermic heat created by their chemical reaction. Being 100% reactive, they evolve no gas or liquid during cure.

Vibrin resins are used primarily with glass or other fibers in the form of cloth or mat to produce thermo-setting reinforced plastic products which are extremely strong and impact-resistant.

Naugatuck is prominent as a supplier of polyester resins for hand lay-up molding of large parts. In the booming boat-building field, Naugatuck is the leading resin supplier.

In addition to a wide range of resins for every type of molding, Naugatuck also offers Vibrin VPA parting agent for easy mold release, and several types of shell coatings to give a smooth, non-porous pigmented outer surface to Vibrin moldings.

Distinctive Properties:

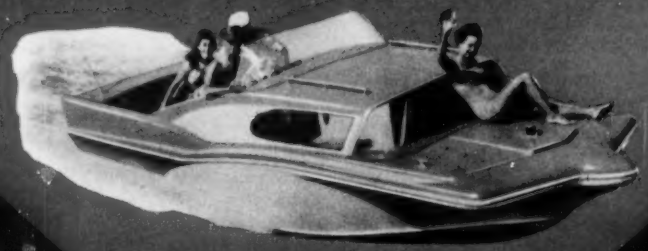
Vibrin, reinforced with glass fibers, has these properties:

- **Stronger per pound than steel**
- **Economical for large prototype production in small or moderate quantities**
- **Non-denting; impact-resistant**
- **Chemical- and weather-resistant**
- **Can be pigmented or painted over**

Major Uses:

- **Boat hulls and deck units**
- **Auto and truck bodies**
- **Sectional swimming pools**
- **Translucent windows and skylights**
- **Chemically inert pipe**
- **Furniture**
- **Corrugated paneling**
- **Machine housings**
- **Fishing rods**
- **Cements and putties**

	VIBRIN 135 High Heat Resistant	VIBRIN 144D Self-Extinguishing	VIBRIN 151 Resilient
DESCRIPTION	Clear liquid triallyl cyanurate polyester resin	Straw-colored, liquid polyester resin Flame-resistant	Clear, liquid polyester resin providing high resilience
SPECIAL FEATURES	High strength retention at 500° F Short term exposure at 600° F	Fire retardant and self-extinguishing	Elongates 5% Has outstanding toughness and impact strength
RECOMMENDED USES	Aircraft, missiles, jets, radomes, heat-resistant parts High temp. electrical parts	For production of products which must not support combustion	Impact-resistant products. Pressure bag, vacuum bag or hand lay-up molding and putties



Radical hull contouring is neither difficult nor very costly when molded of glass-fiber reinforced Vibrin—the boating industry's most widely used polyester.



Glass fibers imbedded in brightly pigmented Vibrin give distinctive textural beauty to this decorator bowl.



Weight-saving reinforced Vibrin is easily fabricated into curved components and allows area reinforcement in sections subject to heavy road shock or impact damage.



Cold frames and green houses of reinforced Vibrin have all the sunlight translucency and transmission of beneficial ultra-violet light needed—yet protect against extremes of weather.

VIBRIN 152-LS-4 Light-Stabilized	VIBRIN 154 Room Temperature Curing	VIBRIN 156 Reactive, Fast Curing Polyester Resin	VIBRIN X1068B Minimum Shrinkage Potting
Higher viscosity liquid polyester resin stabilized to prevent discoloration	Pre-accelerated, thixotropic, polyester laminating resin	Clear, light liquid	Clear amber, accelerated polyester resin
Shows negligible change in color from sunlight and weather exposure	Ready to use after catalyst addition Non-sagging, fast-curing	High hot strength, toughness, rapid cure	Ready to use after catalyst addition. Minimum exotherm and shrinkage
Flat or corrugated panels for colorful outdoor and architectural purposes	Hand lay-up, room temp. curing applications such as boats, pools and tanks	Matched die molding premix compounds. Button molding and casting. Modifications of Vibrin 156 are available for each of above uses	Potting, encapsulating, cements, where minimum stress build-up is important

NAUGATUCK Marvinol

POLYVINYL CHLORIDE RESINS

Polyvinyl chloride resins and their host of varied uses are well known to the industry. As a major supplier of vinyl resins, Naugatuck is constantly developing additional Marvinol resins, of high, medium and low molecular weights, with specific processing and end-product qualities.

The 12 Marvinol resins listed below constitute what is probably the most extensive line of straight PVC resins available for calendering, etc., from any one manufacturer. Of these, VR-22 and VR-23 electrical grade extrusion resins have Underwriters' Laboratories Inc. approval. Marvinol VR-24 is used in semi-rigid insulation for low-voltage communications wiring insulation where UL approval is not required.

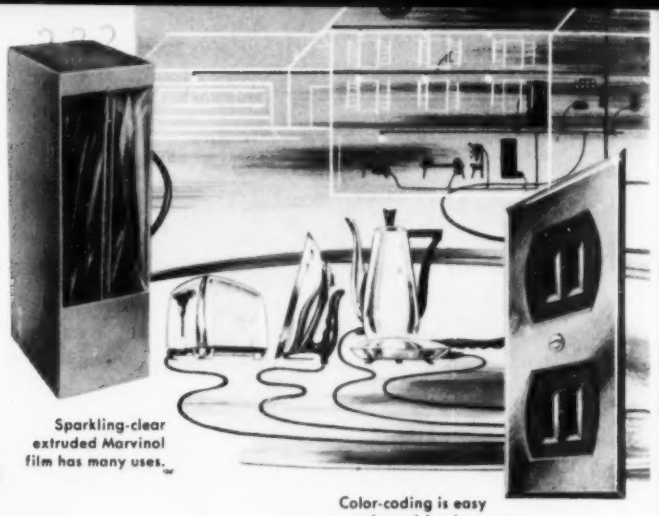
Particularly outstanding in the Marvinol line are the new resins VR-50 and VR-51 recommended for plastisol and organosol applications, since Naugatuck has taken the lead in developing outstanding rheological characteristics in these resins.



	MARVINOL VR-10	MARVINOL VR-12	MARVINOL VR-20	MARVINOL VR-22
Description	Modifying resin for plastisol compounding.	Specialty calendering and extrusion resin.	Specialty film calendering resin.	Electrical grade, hot, dry blend resin for extrusion.
Special Features	High molecular weight resin for modifying plastisol formulations. Imparts dryness of hand (dullness), maintains high physical properties, produces lower Brookfield viscosities, promotes good air release in slush and rotational molding plastisol compounds. Used in blown film formulations for high physicals and speeds.	High molecular weight straight PVC resin for imparting special qualities of dry hand (dullness) coupled with excellent physical properties. Demonstrates fast milling and Banbury mix characteristics together with high premix densities in plasticized formulations. Has outstanding high-speed extrusion properties permitting close dimensional tolerances.	Medium molecular weight. Recommended primarily for calendered film where unusually good light stability and clarity are required. Excellent hot or cold premixing. Has high bulk density for large Banbury charges.	Medium-high molecular weight with high bulk density for large Banbury charges. Excellent mixing cycles for hot, dry blend extrusion. Possesses excellent electrical properties and is approved by Underwriters' Laboratories, Inc. for electrical applications. Inherent heat stability.
Resin Properties				
Specific Viscosity—Ave.	0.52	0.52	0.38	0.44
Average Apparent Density lbs/cu. ft.	28	25	38	29
Average Particle Size, microns	7	8	32	30
Acetone Solubility	20	20	37	25
Specific Gravity	1.40	1.40	1.40	1.40
Ave. ASTM Oil Absorption	0.63	0.95	0.69	0.90
Compound Properties* (100 parts resin, 50 parts DOP)				
Shore "A" Hardness	82	82	78	80
Tensile Strength, psi	2900	2900	2600	2800
Ultimate Elongation, %	340	340	360	340
100% Modulus, psi	1475	1475	1300	1500
Tear Strength, lbs/in.	480	480	430	450



Dolls look and feel lifelike when made of Marvinol



Sparkling-clear extruded Marvinol film has many uses.

Color-coding is easy when wiring is Marvinol-insulated.

Distinctive Properties

Marvinol vinyls may be compounded to yield products having these properties:

- Extreme versatility—from transparent film to opaque rigidity and hardness
- Light weight
- Strength and toughness
- Inert to most chemicals
- Excellent electrical properties
- Resistance to weathering and abrasion
- Flame resistance

MARVINOL VR-23	MARVINOL VR-24	MARVINOL VR-25	MARVINOL VR-31	MARVINOL VR-33	MARVINOL VR-34
Electrical grade, easy processing, hot, dry blend resin for extrusion and calendering.	Easy processing, calendering and extrusion resin.	Low molecular weight processing-aid resin.	Cold, dry premix resin for calendered film, sheeting and coated fabrics.	Cold, dry premix resin for calendered film sheeting and coated fabrics.	Easy processing, cold, dry premix resin for calendered film, sheeting and coated fabrics.
Medium molecular weight with high bulk density for large Banbury loadings. Fast extrusion rates at low power consumption from dry blends or compounds. Superior electrical properties approved by Underwriters' Laboratories, Inc. for electrical applications with excellent heat stability.	Medium-low molecular weight straight PVC. Very high bulk density, valuable processing characteristics in semi-rigid calender formulations. With higher molecular weight resins acts as a processing aid. Useful in rigid and semi-rigid wire extrusion compounds.	Low molecular weight straight PVC resin ideally suited for: A. An additive in vinyl-asbestos flooring formulations and in high-fidelity phonograph record compounds. B. Injection molding of unmodified rigid PVC applications.	Medium-high molecular weight. Gives cold, dry premixes. Leaves mixers clean and minimizes clean-out problems. Excellent for the calendering of film sheeting and coated fabrics.	Medium molecular weight, cold, dry pre-mixing resin. Leaves mixers clean and minimizes clean-out problems. Excellent for calendered inflatable film, for sheeting and for coated fabrics. Excellent heat-sealing properties. Produces outstanding injection-molding compounds.	Medium-low molecular weight, cold, dry premixing resin. Minimizes mixer clean-outs. Mills and Banburys rapidly. Used for calendering film for inflatables, sheeting and coated fabrics where an outstanding easier-processing resin is required.
0.38	0.30	0.25	0.44	0.37	0.34
30	34	38	21	21	21
27	25	25	14	15	16
40	51	62	31	46	48
1.40	1.40	1.40	1.40	1.40	1.40
0.90	0.61	0.53	1.65	1.65	1.60
79	77	75	80	78	78
2600	2200	1400	2800	2800	2400
320	270	250	360	350	320
1450	1300	1200	1425	1450	1350
420	370	280	460	410	400

*Compound properties shown in the table above have been tested on the same equipment. Comparison with similar figures on resins of other manufacturers can be very misleading since values obtained on different equipment may vary widely even though the same methods are used.

Distinctive Properties:

Marvinol vinyls may be compounded to yield products having these properties:

- **Extreme versatility — from transparent film to opaque rigidity and hardness**
- **Light weight**
- **Strength and toughness**
- **Inert to most chemicals**
- **Excellent electrical properties**
- **Resistance to weathering and abrasion**
- **Flame resistance**

Major Uses:

- **Upholstery fabrics**
- **Garden hose**
- **Foamed vinyl sponge**
- **Drapes and shower curtains**
- **Doll bodies and toys**
- **Wire insulation**
- **Leather-like luggage and handbags**
- **Pipe and tubing**
- **Floor tile**
- **Laminates**

INOL VR-33	MARVINOL VR-34	MARVINOL VR-50	MARVINOL VR-51
premix resin for ed film sheeting ed fabrics.	Easy processing, cold, dry premix resin for calendered film, sheeting and coated fabrics.	General purpose, plastisol resin, outstanding for high-shear applications.	Special purpose plastisol resin for low-shear applications and foams.
molecular old, dry pre- sin. ixers clean mizes clean-out for calendered film, for and for coated Excellent ing properties. outstanding -molding ds.	Medium-low molecular weight, cold, dry premixing resin. Minimizes mixer clean-outs. Mills and Banburys rapidly. Used for calendering film for inflatables, sheeting and coated fabrics where an outstanding easier-processing resin is required.	Stirs readily into plasticizers to form plastisols showing very low viscosity, particularly at high shear rates. Excellent for: spread coating, film casting, sprayed-coatings and dipping. Very useful in organisols and modified plastisols.	Readily stirred into plasticizers to form plastisols characterized by low Brookfield viscosity and outstanding air release. Excellent for slush and rotational moldings, open and closed cell vinyl foam.
0.37	0.34	0.50	0.50
21	21	15	15
15	16	1.7	1.7
46	48	22	25
1.40	1.40	1.40	1.40
1.65	1.60	....	....
78	78		
2800	2400		
350	320		
1450	1350		
410	400		

ison with similar figures on resins of other y even though the same methods are used.

Physical Properties
6 mil Film, Fused at 380° F
(100 parts VR-50, 66.6 parts DOP)

	VR-50	VR-51
Tensile, psi	2700	2400
Elongation, %	280	1200
100% Modulus, psi	1300	250

NAUGATUCK Marvibond*

VINYL-TO-METAL LAMINATING PROCESS

The Marvibond process, developed and patented by Naugatuck, is a technique for laminating a specially formulated semi-rigid Marvinol vinyl film or sheeting to almost any kind of sheet metal on a continuous basis. The vinyl provides a permanent, durable and rich-looking finish while the metal supplies structural strength.

Marvibond laminates can be embossed, sheared, drawn, drilled or crimped using standard metalworking equipment. The items shown below only begin to suggest the product possibilities. Marvibond laminates are available from a number of laminators. Write us for the current list of Marvibond licensees.

* U. S. Pat. No. 2,739,706



Sweating glasses and spilled drinks will never mar the smart beauty of this hostess cart's Marvibonded vinyl surfaces.



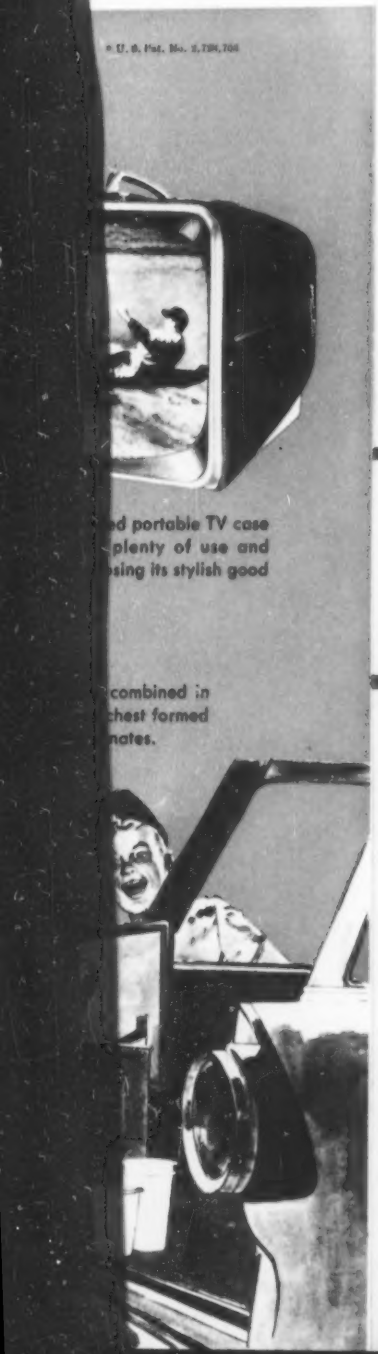
This Marvibonded portable TV case will withstand plenty of use and abuse without losing its stylish good looks.

Beauty and utility are combined in this picnic jug and ice chest formed from Marvibonded laminates.



bond*
OCESS

nates can be em-
rawn, drilled or
ard metalworking
ms shown below
est the product
nd laminates are
umber of lami-
he current list of



d portable TV case
plenty of use and
sing its stylish good

combined in
chest formed
nates.

Among Other Naugatuck Products for the Plastic Industry

Polygard®

an excellent heat stabilizer for high-impact polystyrene and other rubber reinforced plastics.

Tonox-PL

an aromatic diamine curing agent for epoxy resins. Imparts high heat distortion, excellent chemical resistance, and good electrical properties at low cost.

Celogen®
Celogen-AZ®

blowing agents for polyethylene, polyvinyl chloride, and epoxies. For lightness, buoyancy, thermal insulation, and improved electrical properties.

Nothing herein contained is to be construed as a recommendation to use any product sold by United States Rubber Company in such a way as to infringe any existing patent.

Naugatuck Technical Service

Expert technical assistance in the selection, formulation and application of all Naugatuck resins is available from any of the branch offices listed below. If your problem is complex, it will be referred to our research and development men at our Naugatuck laboratories.

United States Rubber

Naugatuck Chemical Division, NAUGATUCK, CONNECTICUT

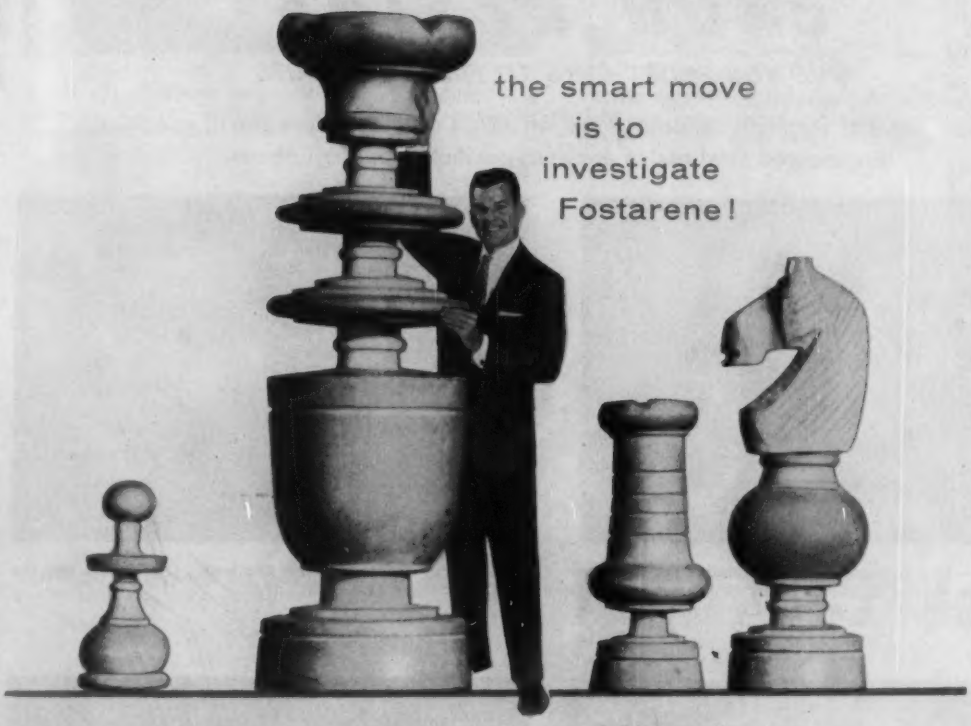
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

General Sales Office...Naugatuck, Connecticut...Tel. Park 9-5241

BRANCH OFFICES:

Dedham, Mass...100 Route 128...Tel. Dedham 3-6000
New York...1230 Avenue of the Americas...Tel. Circle 7-5000
Philadelphia...Fifth and Locust Streets...Tel. Walnut 5-7445
Gastonia, N.C....214 West Ruby Avenue...Tel. University 4-3411
Akron...Pilgrim Square, 9 Overwood Rd. at West Market...Tel. University 4-2145
Chicago...4135 South Pulaski Road...Tel. Cliffside 4-5700
Los Angeles...5901 Anaheim-Telegraph Road...Tel. Raymond 3-1171
Memphis...1480 North Thomas Street...Tel. Jackson 7-2411
Canada...Naugatuck Chemicals...Elmira, Ontario...Tel. Mohawk 9-3466

7.57 - 40 M



You've got a molding problem! You want a polystyrene that's more durable, more lustrous, more dependable in its yield of perfect pieces.

Have you looked into Fostarene?

Fostarene is a product of a pioneer in plastics for over 30 years. In talent and equipment, Fostarene's research facilities are second to none . . . *and growing!*

The result: Better performance, better service for more and more molders who have made the discovery *you* can make—that when it comes to polystyrene, the smart move is to investigate Fostarene.

FOSTARENE

STYRENE PLASTICS • GENERAL-PURPOSE • HIGH IMPACT • HIGH FLOW

AVAILABLE IN PELLETS, GRANULES AND FINE GRIND FOR DRY COLORING . . . IN CRYSTAL CLEAR AND A FULL RANGE OF CUSTOM COLORS

EXCLUSIVELY REPRESENTED BY: H. MUEHLSTEIN & CO., INC. 60 E. 42nd St., N.Y. 17
BRANCH OFFICES: AKRON • CHICAGO • BOSTON • LOS ANGELES •
WAREHOUSES: AKRON • CHICAGO • BOSTON • LOS ANGELES • JERSEY CITY

MANUFACTURED BY: FOSTER GRANT CO., INC., PETROCHEMICAL DIVISION
MONOMER PLANT, BATON ROUGE, LA. • POLYMERIZATION PLANT, LEOMINSTER, MASS.
A PIONEER IN PLASTICS FOR OVER THIRTY YEARS

FIRESTONE PLASTICS CO.

Chemical Sales Division—Dept. 742H, Pottstown, Pa.

A Division of the Firestone Tire and Rubber Company

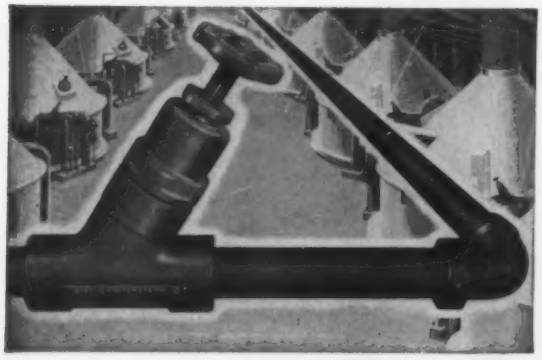
THE PIN-POINTED PROPERTIES OF

Firestone

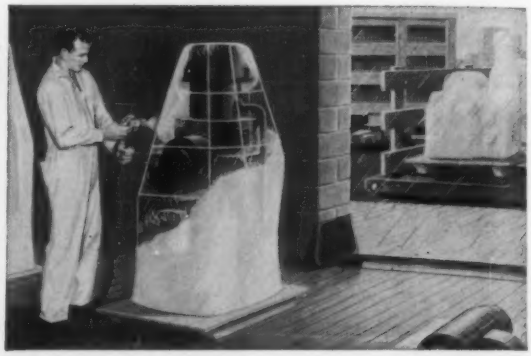
EXON RESINS

GIVE YOU SHORT CUTS TO FINER PRODUCTS

Here are just 9 of the many different ways industry's most complete line of specifically engineered vinyl resins answer specific production needs.



EXON 402-A—Top corrosion-fighter in industry. Can be processed into a variety of useful forms such as sheets and rods. Can be cemented or welded. Lightweight, easy to work.



EXON 450—Ideal for strip coatings. Good solubility, film tensile strength and durability.



EXON 468—Engineered for flooring. High bulking density increases banbury output 10 to 25%. Fast fusing at low temperatures for much easier, more efficient processing.



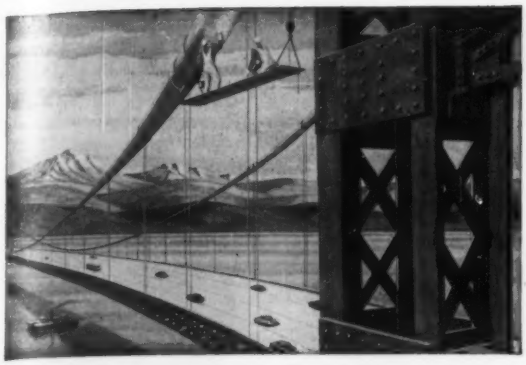
EXON 470—Exhibits excellent adhesion to metals, alkyd and vinyl surfaces. Compatible with a wide range of drying oils, alkyds, phenolics, melamines. High solubility in inexpensive solvents.

PLUS . . . **EXON 461**—a unique fluorine-containing resin combining high solubility, unusual chemical resistance, heat stability and weatherability.

EXON 500—specifically engineered for wire insulation with superior electrical properties.

EXON 700 XR 59—an exceptionally fast-fusing latex for impregnation.

EXON 485—For superior strip coatings. Lower viscosity makes application easier and shelf-lift better. Good clarity.



EXON 471—Excellent weatherability and durability in a protective coating. Corrosion resistant. No measurable change after sunlamp exposure for 360 hours as 1 mil film.



EXON 480—For phonograph records. High bulking density and easy processing at low temperatures. Completely compatible with extender resins, stabilizers and pigments.



EXON 481—Makes possible colorful, abrasion-proof, washable coatings that resist fading or cracking.



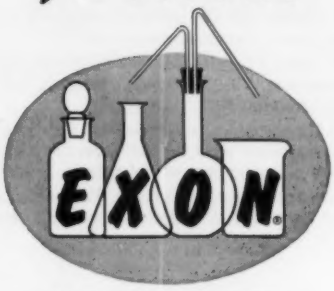
EXON 654—The versatile plastisol resin. Basis of vinyl foam tailored to your needs. A top performer for slush molding, rotational casting, fabric coating. Needs no grinding.



EXON 905-915-925—Temperature tailored, they free your processing from restrictions due to temperature limitations. Blend speedily, fuse quickly.

The versatility of Exon vinyl resins has been demonstrated in far more applications than we have space to describe. The uses mentioned only *typify* the economy, efficiency, and ease of processing for which these resins are engineered.

Firestone



For complete information or technical service, call or write:

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY
DEPT. 742H, POTTSTOWN, PA.
A DIVISION OF
THE FIRESTONE TIRE AND RUBBER CO.

DESIGN ACHIEVEMENTS WITH SUPRAMICA* ceramoplastics

SUPRAMICA ceramoplastics . . . . . .

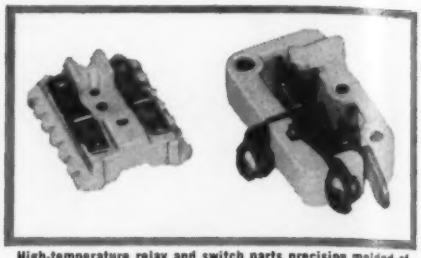
MOLDED OR MACHINABLE HIGH TEMPERATURE INSULATION

Supramica ceramoplastics, the world's most nearly perfect high temperature insulations, are formulated with SYNTHAMICA* synthetic mica. Supramica possesses high temperature and thermal shock resistance, and complete dimensional stability. Thermal expansion coefficients are the same as steel. They have low electrical loss, excellent arc resistance, high dielectric strength, and are impervious to moisture, oil and organic solvents, with permanent resistance to radiation.

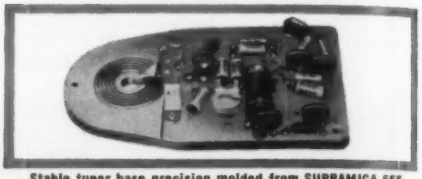
SUPRAMICA* 560 — New insulation for **continuous operation** at 500° C (932° F). Lightweight material can be precision molded with fragile inserts . . . specified for conditions **which no other material can meet!** Specific gravity similar to that of aluminum or mineral-filled polyesters . . . perfect for relay bases, connectors, radomes, tube sockets and other components for high temperature use.

SUPRAMICA* 555 — Precision-molded ceramoplastic having high-temperature endurance up to 750° F. Moldable with or without inserts.

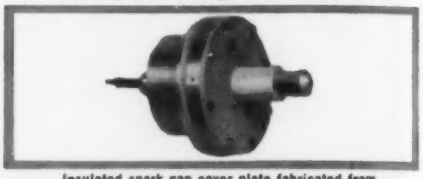
SUPRAMICA* 500 — Compression-molded ceramoplastic sheets and rods for use at temperatures up to 900° F. Readily machinable; not precision moldable. Inserts must be cemented.



High-temperature relay and switch parts precision molded of SUPRAMICA 560 ceramoplastic



Stable tuner base precision molded from SUPRAMICA 555 ceramoplastic with fragile silver ribbon insert



Insulated spark gap cover plate fabricated from SUPRAMICA 500 ceramoplastic

MYCALEX* glass-bonded mica . . .

MOLDED OR MACHINABLE ELECTRICAL INSULATION

Mycalex glass-bonded mica formulations have been recognized for many years as high-temperature, high-frequency insulation . . . impervious to oil and water, resistant to high temperatures, with total, permanent dimensional stability and thermal expansion coefficient equivalent to that of insert metals . . . resistant to radiation.

MYCALEX 410* Glass-bonded mica precision-molded with or without inserts, for applications involving temperatures up to 650° F.

MYCALEX 400* Standard compression molded glass-bonded mica for operating temperatures to 850° F. Readily machinable, but not moldable. Inserts must be cemented.

MYCALEX* 385 Glass-bonded mica with excellent resistance to circuit breaker arcing and thermal shock, for continuous operating temperatures up to 700° F. Readily machinable, but not moldable in intricate shapes.

MYCALEX* K (machinable) and KM (moldable) Glass-bonded mica capacitor dielectrics with higher dielectric constant indicated by numbers 10, 20, 30.



High shock potentiometer parts precision molded with steel supporting inserts — MYCALEX 410 glass-bonded mica



Radar insulating parts fabricated from MYCALEX 400 glass-bonded mica



Circuit breaker arc chute fabricated from MYCALEX 385 glass-bonded mica

* "SUPRAMICA", "MYCALEX", "400", "410", are registered trade-marks of MYCALEX CORPORATION OF AMERICA; "500", "555", "560" and "385" are trade-marks of MYCALEX CORPORATION OF AMERICA

"SYNTHAMICA" is a trade-mark of SYNTHETIC MICA CORPORATION, a subsidiary of MYCALEX CORPORATION OF AMERICA.

AND MYCALEX* glass-bonded mica . . . . . .



MYCALEX TM Commutation Switch with commutator plates precision molded of SUPRAMICA 555 ceramoplastic. Plate is CP-346, 2-poles, 360 contacts.

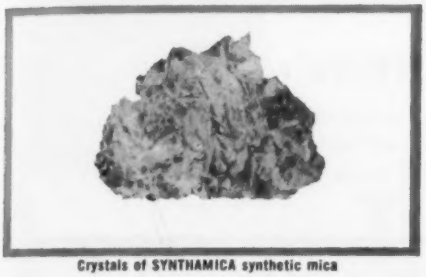
MYCALEX TM telemetering switches

WITH SUPRAMICA CERAMOPLASTIC COMMUTATOR PLATES ASSURE RELIABLE OPERATION UNDER EXTREME CONDITIONS

Precision-molded Supramica ceramoplastic commutator plates have introduced a degree of accuracy and sustained dependability never before approached in telemetry. Where warpage of only .0002" of the commutator plate will distort and destroy the value of the signal, these precision switches withstand extremes of temperature, altitude, shock and vibration and deliver a clean, unvarying signal . . . tests show completely satisfactory performance of these switches after more than 1000 hours at 1200 RPM.

In military and industrial applications, Mycalex TM Telemetering Switches with Supramica ceramoplastic commutator plates have made significant contributions to the reliability of electronic equipment.

MYCALEX ELECTRONICS CORPORATION



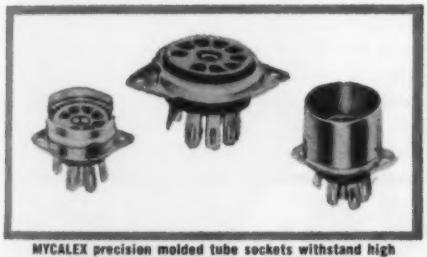
Crystals of SYNTHAMICA synthetic mica

SYNTHAMICA* synthetic mica . . . .

Available in commercial quantities, as powder, flake or crystal, and in chemically bonded sheets for all applications in the electronic, communications and related industries. Manufactured from readily available native raw materials, Synthamica synthetic mica is an important contribution to the development of military and civilian electronics.

Synthamica synthetic mica is chemically pure, hydroxyl free, and will withstand temperatures almost twice as high as its natural counterpart. One of the outstanding properties of this crystal clear material is the freedom from outgassing at elevated temperatures and pressures.

SYNTHETIC MICA CORPORATION
A Subsidiary of MYCALEX CORPORATION OF AMERICA



MYCALEX precision molded tube sockets withstand high temperatures and rugged service. Standard miniature and subminiature types.

MYCALEX tube sockets . . . . . .

High temperature tube sockets made from Supramica ceramoplastic and Mycalex glass-bonded mica are produced under exclusive license of Mycalex Corporation of America.

Supramica 560 ceramoplastic tube sockets have successfully passed operating tests at 500° C.

MYCALEX TUBE SOCKET CORPORATION

Write today for complete technical information concerning any of the above products or materials.

MYCALEX
CORPORATION OF AMERICA

GENERAL OFFICES AND PLANT:
CLIFTON BOULEVARD
CLIFTON, NEW JERSEY

EXECUTIVE OFFICES:
30 ROCKEFELLER PLAZA
NEW YORK 20, NEW YORK

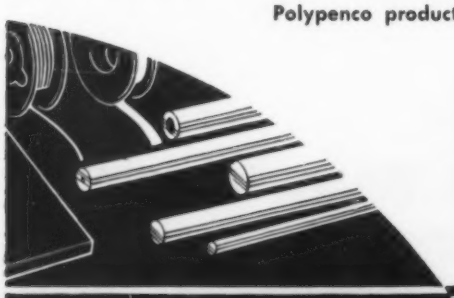
SALES OFFICES:
CHICAGO — DAYTON
LOS ANGELES — MIAMI
WASHINGTON

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS

Design today for tomorrow's products . . .

Select **POLYPENCO®** Industrial Plastics

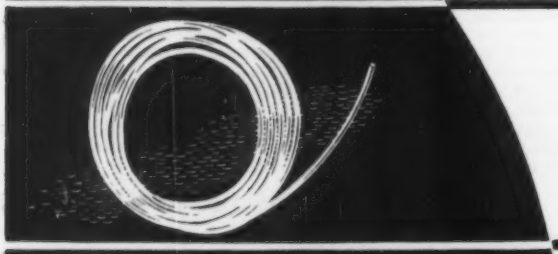
Polypenco products and engineering service are your answer to new developments, improved quality, lower costs.



Industrial plastics with distinctive quality and performance:

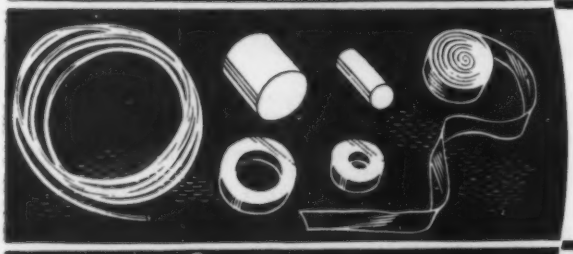
STOCK SHAPES FOR MACHINING

Polypenco Nylon: rod, strip, tubular bar, plate, tubing
Polypenco Teflon*: rod, tubing, tape, sheet, spaghetti tubing
Polypenco Q-200.5: (cross-linked polystyrene): rod and plate
Polypenco K-51: (chlorinated polyether): rod, strip, tubular bar
. . . from The Polymer Corp. of Penna.



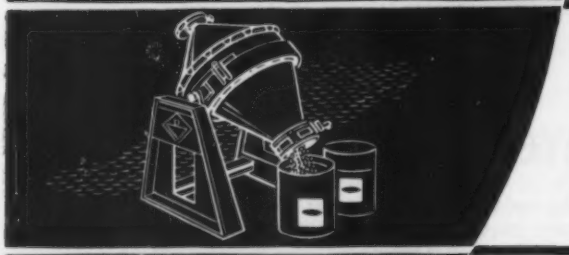
NYLAFLOW® PRESSURE TUBING

A specially processed flexible polyamide tubing for conveying air, gases or liquids.
. . . from The Polymer Corp. of Penna.



FERROTRON® Ferromagnetic Materials

A superior powdered iron filled plastic — available in rigid cores and flexible rod and tape.
. . . from The Polymer Corp. of Penna.



POWDERS For Molding And Processing

NYLATRON® specially compounded nylon molding powders.
NYLASINT® finely divided nylon powders for cold pressing and sintering.
WHIRLSINT+ coating powders for use in the Whirlclad Coating Process.
. . . from National Polymer Products, Inc.



WHIRLCLAD+ Coating Process

For the improved application of nylon, polyethylene and other coating materials to metals, ceramics, wood and other base materials.
. . . licensed by Polymer Processes, Inc.

Let Polymer's Technical Service Department help on your design problem. Write today for further information.

POLYPENCO

THE POLYMER CORP. OF PENNA.
NATIONAL POLYMER PRODUCTS, INC.
POLYMER PROCESSES, INC.

Subsidiaries of
THE POLYMER CORPORATION, READING, PA.
Export: POLYPENCO, INC., Reading, Pa., U.S.A.

+ Trademark
* DuPont Trademark



Europe's oldest and
largest manufacturer of plastics.
50 years of research and
development have assured
Troisdorf Plastics a leading
position in the world's markets.
10 thousand skilled workers
and employees are capable of solving
your plastics problems.
Out of the multitude of our products,
we would like to draw
your special attention to the following:
Semi-finished products like tubes,
rods, sheets and laminates
on the base of
PVC and Copolymers
Celluloid and Celluloseacetate
Phenol-Formaldehyde-resins
Melamine-phenol-kresole-resins
Polyamide and others

Troisdorf plastics

Inquiries invited by our
General Representatives
in U.S.A.:
Georg von Opel Corporation
15 William Street
New York 5, N. Y.
Telephone: Hanover 2 6156-58
Cable: Geovonopel, New York
in Canada:
Industria (Ore & Chemicals) Ltd.
2435 Lucerne Road
Montreal 16, P. Q.
Telephone: Regent 1-1188
Cable: Transpyrit, Montreal

DYNAMIT-ACTIEN-GESELLSCHAFT VORMALS ALFRED NOBEL & CO.
Troisdorf/Köln — Western Germany



Creating a new product? Anxious to improve an old product? Getting breakage or failures in an existing product? Using costly die cast metals? Having corrosion problems?

Contact FIBERITE for the *right* reinforced phenolic or melamine. FIBERITE's experience and wide selection of formulations can solve your problems and reduce your costs.

Shown below are three new products molded from different FIBERITE formulations. All have replaced a die cast or fabricated metal part. Complete data available on request.

SAFE! New grain conveyor bucket won't spark...won't wear...keeps its shape ...won't rust or corrode

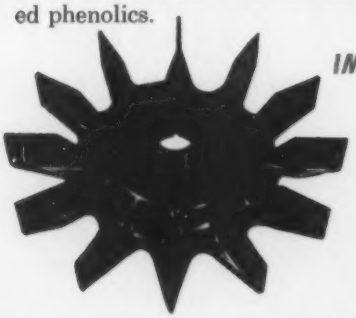
Maybe your product calls for excellent resistance to wear and high dimensional stability like this grain conveyor bucket. If so, you'll want to know more about F.M. 3510, one of FIBERITE's cotton fabric reinforced phenolics.



MOLDED OF F. M. 3510

Impact Strength	2.4 (Ft. Lbs. in Notch)
Flexural Strength	14,600 PSI
Tensile Strength	7,500 PSI
Dielectric Strength	275 (Dry) short time V/M
Specific Gravity	1.37 Molded

IMPROVED IMPELLER! forces air through electric motors... accurately molded in 7 sizes



MOLDED OF F. M. 1132

Impact Strength	1.7 (Ft. Lbs./ in Notch)
Flexural Strength	14,000 PSI
Tensile Strength	7,000 PSI
Dielectric Strength	300 (Dry) short time V/M
Specific Gravity	1.37 Molded

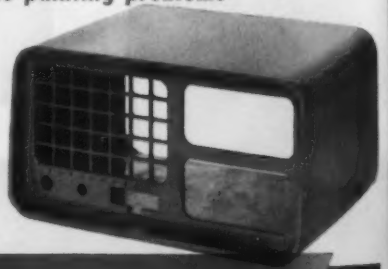
The advantages of molding this impeller of FIBERITE's cotton fabric reinforced phenolic F.M. 1132 include light weight, no static, won't bend or dent, will not cause a spark, and results in lower fabrication costs. Complete data on F.M. 1132 available on request.

NEW STRENGTH! new beauty in this intercom cabinet...eliminates painting problems

This intercom cabinet molded of FIBERITE's cotton fabric reinforced melamine 2015 is colorful and attractive, yet built to take abuse. Find out how this and other FIBERITE formulations can help you.

MOLDED OF F.M. 2015

Impact Strength	1.0 (Ft. Lbs./ in Notch)
Flexural Strength	16,000 PSI
Tensile Strength	7,000 PSI
Dielectric Strength	225 (Dry) short time V/M
Specific Gravity	1.52 Molded
Color	Any



Write, wire or phone for complete data on FIBERITE formulations Dept. MP-6

THE FIBERITE CORPORATION

Manufacturers of Plastic Molding Materials

Office and Factory, Winona, Minnesota Phone 2316

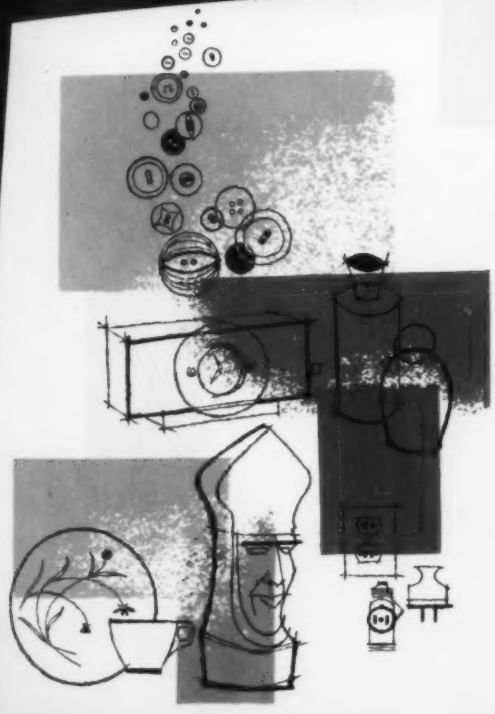
Plaskon®

UREA

MELAMINE

ALKYD

NYLON



Molding Compounds
point the way to:
NEW PRODUCTS...
NEW USES...
NEW MARKETS...

Allied Chemical

BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION

ADD SALES APPEA

WITH Plaskon UREA AN



FOR SMOOTH, HARD, ENDURING SURFACES . . .

"MOLDED-IN" COLOR

Nothing sells like color—especially when it's permanently molded into the product—virtually indestructible color that can't peel, chip or wear off. PLASKON Urea and Melamine offer complete freedom of color selection — over 12,000 colors!

HEAT RESISTANCE

These thermosetting plastics will not soften or discolor when exposed to elevated temperatures.

CHEMICAL RESISTANCE

Urea and Melamine effectively resist common organic solvents, soap, borax, oils and greases.

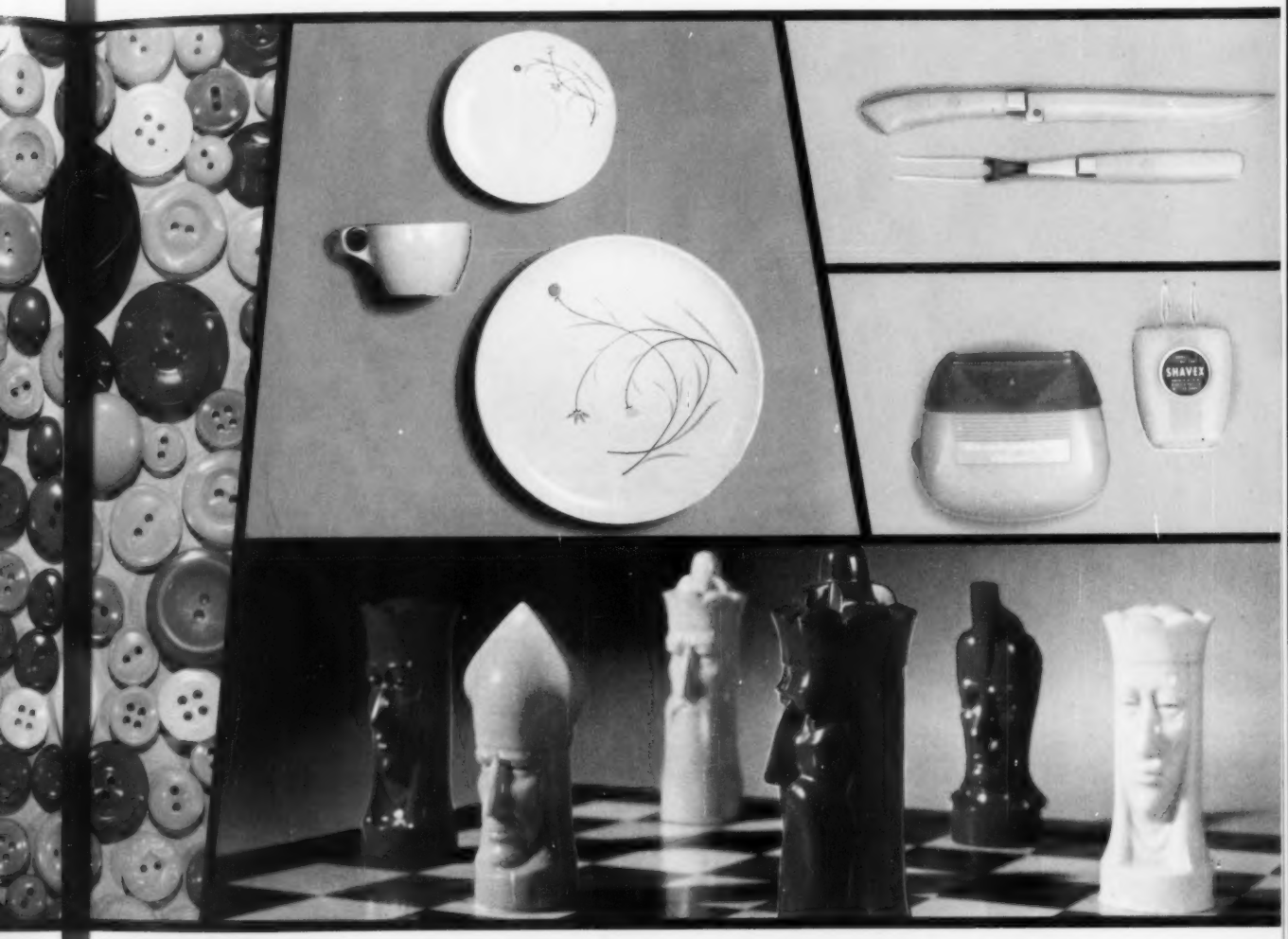
QUALITY

Pleasantness to the touch is an added sales appeal offered by products molded of Urea and Melamine. They feel warm and smooth, are non-electrostatic and will not attract dust or dirt.

For technical service, marketing counsel or more complete information on any PLASKON Molding Compound . . .

TO YOUR PRODUCTS

MELAMINE MOLDING COMPOUNDS



NOW IN MORE THAN 12,000 "MOLDED-IN" COLORS!

HIGH STRENGTH

Urea and Melamine products have extra hard, durable surfaces that resist scratching and chipping. Their rigidity and strength make them popular for a wide range of consumer and industrial products.

SUPERIOR ELECTRICAL PROPERTIES

PLASKON Urea and Melamine have high electrical insulation values and arc resistance—and are self-extinguishing. They provide a margin of safety and performance characteristics that allow greater freedom in the design of many new electrical products.

HOUSING TYPE UREA

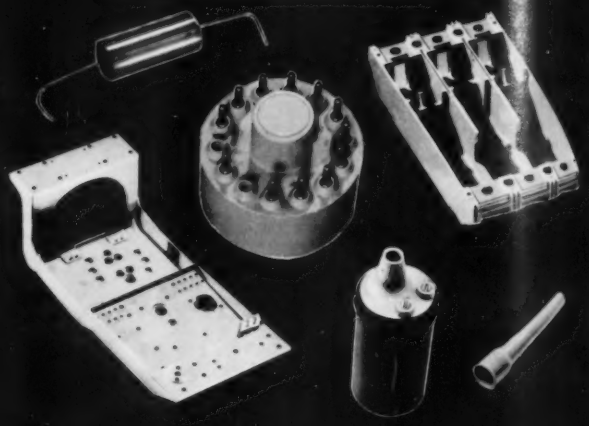
The recent development of a Urea compound with easier moldability and greater fusibility makes possible the use of Urea in larger cabinet applications such as TV sets, business machines and air conditioners.

contact: BARRETT DIVISION, Allied Chemical & Dye Corp., 40 Rector Street, New York 6, N. Y. · HAnover 2-7300

Plaskon
NYLON
MOLDING AND EXTRUSION COMPOUNDS



Plaskon
ALKYDS
FOR CRITICAL ELECTRICAL PARTS



8200 FOR MOLDING

This type 6 nylon is noteworthy because of its amazing versatility. It possesses the most desirable properties of other type nylons—such as toughness . . . sterilizability . . . light weight . . . abrasion, corrosion and heat resistance . . . high impact strength. In addition, it offers many new advantages including:

1. *Better dimensional stability due to lower shrinkage, moisture expansion, thermal coefficient of expansion*
2. *Fewer voids during molding*
3. *Greater impact strength—with no loss in flexural or tensile strength*
4. *Can be molded in thin (up to .030") transparent sections*
5. *Can be colored more readily*
6. *Molds at lower cylinder temperatures*

PLASKON Nylon 8200 is being used in such hard working products as: gears, valves, cams, bearings, pipe fittings, shoe heels—and dozens more. Scores of new applications are still in the developmental stage.

8201 FOR EXTRUSION

PLASKON Nylon 8201 extrusion compound has the same exceptional properties as PLASKON 8200. Its low moisture content and wide range of permissible stock temperatures (450-550 F.) make extrusions run more smoothly. Its high molten viscosity facilitates the extrusion of tapes, film, shapes, rods and tubing in a wide range of cross sections.

A few of PLASKON Nylon 8201's present uses include: transparent film (can be vacuum formed), lubrication system tubing, fuel lines, wire coverings, window channels, tapes for stamping, monofilament. Several types are available to meet your specifications.

OUTSTANDING ELECTRICAL PROPERTIES

PLASKON Alkyds resist arcing better than any other thermosetting plastic material. And the dielectric strength of molded alkyd parts is exceptional. Alkyd parts also show a low loss factor and high resistivities.

EXCELLENT RESISTANCE AND DIMENSIONAL STABILITY

PLASKON Alkyds offer unexcelled dimensional stability due to their high degree of resistance to both moisture and heat. Alkyd parts will perform, without thermal degradation, at continuous exposures of 325 F. Once molded to specifications, no measurable after-shrinkage occurs.

AUTOMATION

Alkyds are suitable for use on high-speed automatic molding equipment . . . they mold four times faster than conventional thermosetting materials. Reinforced Alkyds require only medium molding pressures and non-reinforced Alkyds mold at very low pressures. All of these advantages add up to fast, economical production rates.

HIGH STRENGTH OF REINFORCED ALKYDS

The strength range of reinforced Alkyds surpasses that of any other impact thermosetting molding compound. They are easier to handle and cure more rapidly. In addition, resin and fibers remain practically inseparable during molding—even in thin-walled sections.

For full technical data, including specific performance characteristics, write: BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y. • HAnover 2-7300



Market ideas for reinforced plastics

GLIDPOL polyester resins . . . for strong, lightweight molded luggage!

You, as a fabricator, may find new markets for your production in these applications.

Want your share of a $200 million market? Then, investigate luggage, specifically matched-die molded luggage of fibrous glass, reinforced with GLIDPOL* polyester resins.

Stronger than steel but very lightweight, it outlasts other types, won't stain, mar or split. It's eye-pleasing, too, because pigmented GEL-KOTE* coatings provide a smooth, snag-free surface, plus permanent, fade-proof color. Another advantage: GLIDPOL resins allow great design flexibility, permit the assembly of complete matched sets from just a few basic shells.

Versatile GLIDPOL and GEL-KOTE resins are also used in the production of appliances, boats, vehicle bodies and hundreds of other products.

*A Glidden Trade-Mark



A request on your company letterhead will bring you a copy of Technical Bulletin MPE-57 which fully describes all of the Glidden GLIDPOL resins for casting, laminating, molding and coating.

GLIDPOL POLYESTER RESINS

QUALITY Glidden PRODUCTS

THE GLIDDEN COMPANY • INDUSTRIAL FINISHES DIVISION • 900 Union Commerce Bldg., Cleveland 14, Ohio

San Francisco • Los Angeles • Chicago (Nubian Division—1855 N. Leclaire Ave.) • Minneapolis • St. Louis • New Orleans • Cleveland • Atlanta • Reading. Canada: Toronto and Montreal

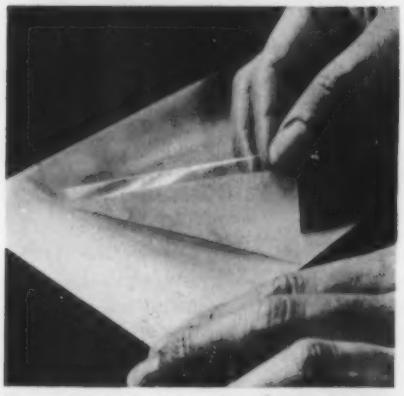
R&A Adhesives

for **all** plastics and **all** metals



RIGID

Acrylics; cellulosics; polystyrene and co-polymers; vinyl; nylon; vulcanized fibre; hard rubber; reinforced laminates of silicone, urea, melamine, polyester, phenolic, epoxy; flourinated resins; etc., and all metals.



FLEXIBLE

Cellophane; cellulose acetate; cellulose acetate butyrate; cellulose nitrate; Mylar; Pliofilm; polyethylene; polyvinyl alcohol; polystyrene; Saran; vinyl; etc., and all foils.



EXPANDED FOAMS

Polyurethane (polyester-isocyanate); polyvinyl chloride; polystyrene; epoxies; phenolics; etc.

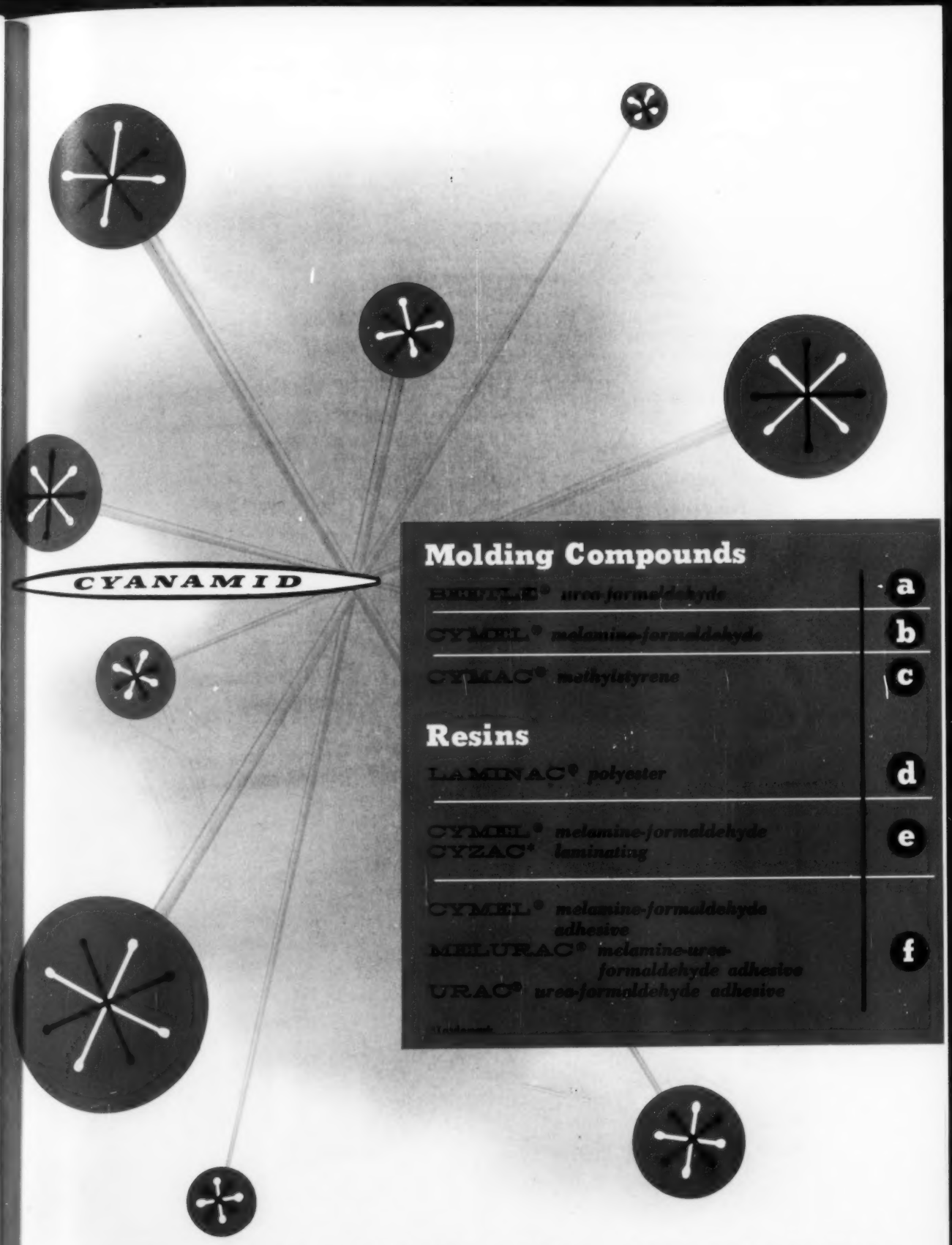
If you will give us the details of the adhesive problems you face, chances are we can show you a case history of a similar production problem that has been successfully solved with one of the more than 650 current "BONDMASTER" adhesives.

And if yours is truly "special", our extensive laboratories backed by more than 43 years of experience in the exclusive manufacture of industrial adhesives can probably "custom build" a formulation to answer your specific needs.

Write today for profusely illustrated technical literature and detailed Problem Analysis Form . . . without cost or obligation.

RUBBER & ASBESTOS CORP.

245 BELLEVILLE AVE., BLOOMFIELD, NEW JERSEY



AMERICAN CYANAMID COMPANY

Plastics and Resins Division

BEETLE®

Urea-Formaldehyde alpha cellulose-filled Molding Compounds

Thermosetting

for properties see pages 6-7

BEETLE Molding Compounds produce marproof, lustrous moldings highly resistant to detergents, oils and greases. They are supplied in powder or granular form and various plasticities to meet specific molding needs in compression molding. Typical applications include radio cabinets, stove hardware, closures, electric appliance housings, wiring devices, cosmetics containers.

BEETLE is formulated to meet these specifications:

Federal L-P-406A, LC 726-1
ASTM D705-49, Grade I (Arc resistance limits are in process of revision by ASTM)

characteristics

Unlimited range of lustrous colors
Smooth, hard surface
Odorless and tasteless
Stain-resistant
Wear-resistant
Arc-resistant
Track-resistant
Dielectric strength
Durable



CYANAMID

BEETLE®

a



AMERICAN CYANAMID COMPANY

Plastics and Resins Division

for properties see pages 6-7

CYMEL *Molding Compounds are available in the following formulations to fill a variety of industrial and consumer applications. In general, they are suitable for compression, transfer or plunger molding.*

CYMEL 1077-1079
alpha cellulose-filled

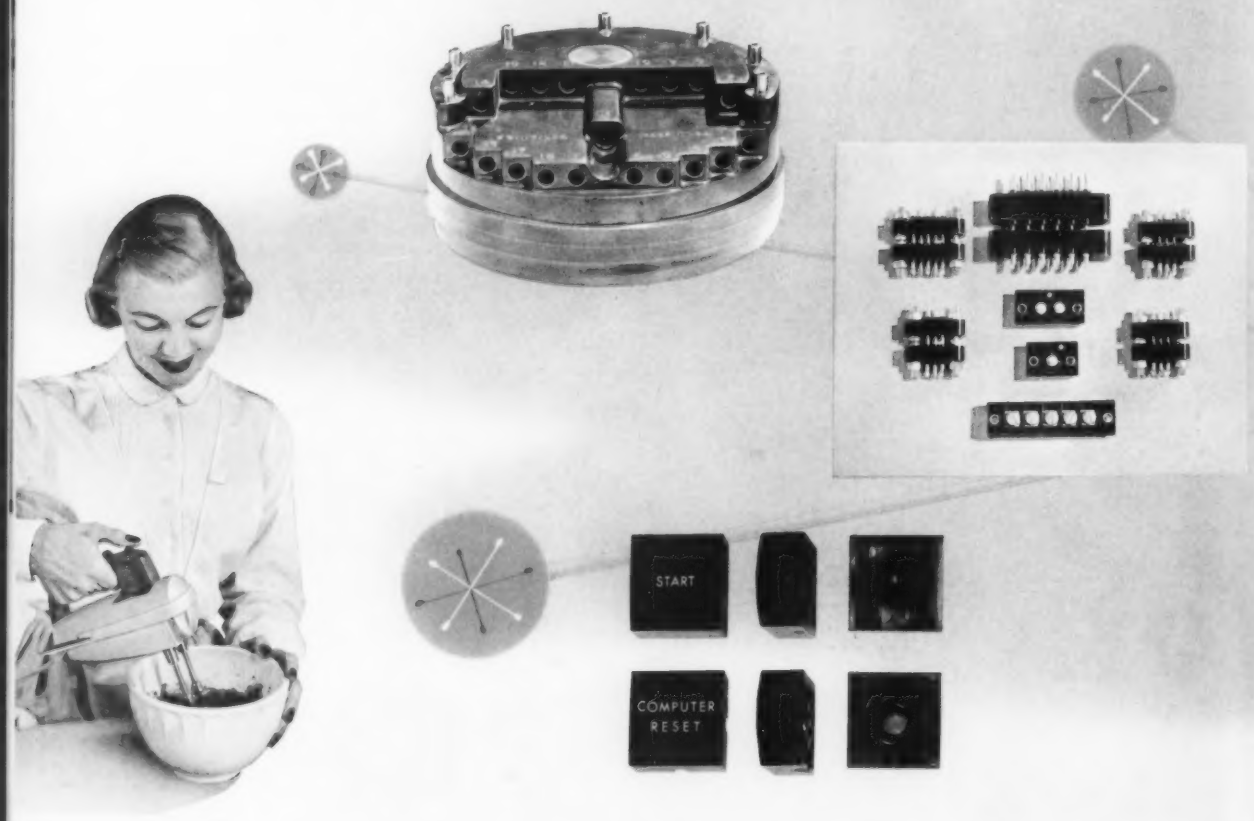
Available in any color for molding such products as dinnerware, buttons, electric mixer and shaver housings. Characteristics: Break and heat resistance; extraordinary surface hardness; rich, lustrous look and feel; excellent chemical resistance; excellent electrical properties, including arc and track resistance.

CYMEL 592
asbestos-filled

Available in brown only for electronic equipment, aircraft and automotive ignition parts, circuit breakers. Characteristics: Excellent arc resistance and dielectric strength at elevated temperatures; dimensional stability; resistance to atmospheric extremes.

CYMEL 1500
wood flour-filled

General purpose arc resistant, electrical grade material for watt-hour meter blocks, automotive ignition parts. Characteristics: Exceptional arc resistance, excellent dielectric strength. Brown only.



CYANAMID

CYMEL®

b

CYMEL 1502
cellulose-filled

Arc resistant, electrical grade material for connector plug inserts, circuit breakers, automotive ignition parts. Characteristics: Particularly good dimensional stability, dielectric strength. Insert retention is excellent. Brown only.

CYMEL 3135
glass fiber-filled

Electrical grade material with high impact resistance, extraordinary flame resistance, excellent arc resistance, low shrinkage and moisture absorption. Natural color..

CYMEL 3136
granular glass-filled

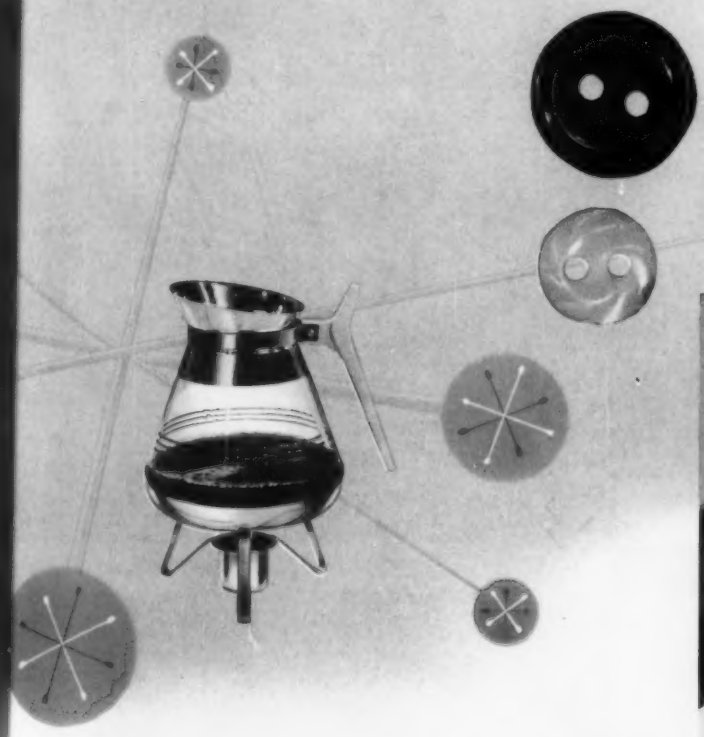
Electrical grade material with intermediate strength, excellent arc and insulation resistance, extraordinary flame resistance, low shrinkage and moisture absorption. Natural color.

CYMEL 3020
chopped cotton fabric-filled

Ideal for products requiring resistance to impact as well as heat and chemicals. Good arc resistance. Black only.

CYMEL 404
unfilled

Highly translucent, granular material for decorative effects. Used principally for button and jewelry findings.





BEETLE® CYMEL®

Molding Compounds properties

Tests and Conditioning Procedures[1]		Beetle Alpha-Urea	Cymel 1077-1079 Alpha-Mel.
Compression Ratio (Bulk Factor)		Loose-packed	2.1
Tabletting		———	Excellent
Plasticity Range		———	V. Soft--Hard	Soft—Med. Hard
Moldability in Compression Molds		———	Excellent	Excellent
Compression Molding Temperature—°F		———	275—350	310—340
Compression Molding Pressure—PSI		———	2,000—8,000	1,500—6,000
Moldability in Transfer Molds		———	Special	Good
Transfer Molding Temperature—°F		———	Type	300—320
Transfer Molding Pressure—PSI		———	Recommended	4,000—12,000
physical				
Shrinkage (4" x ⅛" Disc, CMCP)—Ins/Inch		Cyanamid	0.006—0.009	0.007—0.009
Additional Shrinkage—48 Hours at 220°F		D-1299-53T	0.006—0.012	0.006—0.008
Specific Gravity		D-792-50	1.5	1.5
[1] Molded Density—Grams/Cubic Inch		———	24.6	24.6
Machining Quality		———	Good	Good
Thermal Coefficient of Expansion—Linear/°C		D-696-44	A	22—36 x 10^{-6}	20—57 x 10^{-6}
Thermal Conductivity—Cals/SqCm/Sec/°C/Cm		C-177-45	A	10.1 x 10^{-4}	10.1 x 10^{-4}
Heat Distortion Point—at 264 PSI—°F		D-648-45T	A	266	410
[2] Heat Resistance (⅛" Section—°F)		———		170	210
Flammability		———		Self-Exting.	Self-Exting.
Boiling Water—1 Hour		Cyanamid		0	0
Water Absorption—24 Hours at 25°C—%		D-590-42 (Mod.)		0.4—0.8	0.1—0.4
Light Transmission—%		D-1003-52		21.8	14.5
Resistance to Sunlight		———		Pastels gray	Pastels yellow
Color Possibilities		———		Unlimited	Unlimited
Impact Strength, Izod, Milled—FtLbs/Inch		D-256-47T	A	0.24—0.28	0.24—0.28
Compressive Strength—PSI		D-695-49T	A	30,000—38,000	40,000—45,000
Rockwell Hardness		D-785-48T	A	E94--97	E110
Shear Strength (1" Diameter Slug)—PSI		LP-406-A (Fed.)		11,000—12,000	11,000—12,000
Flexural Strength (¼" x ½" x 5" Bar)—PSI		D-790-49T	A	11,000—18,000	12,000—15,000
Deflection (¼" x ½" x 5" Bar)—Inches		D-790-49T	A	0.103—0.157	0.107—0.162
Elongation in Flexure at Failure—%		———	A	1.0	0.9
Modulus of Elasticity—Flexure—PSI		Cyanamid	A	1.4—1.5 x 10^{6}	1.5 x 10^{6}
Modulus of Elasticity—Tension—PSI		D-633-49T	A	1.3—1.4 x 10^{6}	1.35 x 10^{6}
Tensile Strength—PSI		D-638-49T	A	5,500—7,000	7,000—8,000
electrical				
[3] Dielectric Strength—(⅛" Section in Oil):				
Short Time—Volts/Mil at 25°C		D-48-52T	A	330—370	310—330
—Volts/Mil at 100°C		D-48-52T	A	200—270	170—210
Step-by-Step—Volts/Mil at 25°C		D-48-52T	A	220—250	220—230
—Volts/Mil at 100°C		D-48-52T	A	110—150	90—130
Slow-Rate-of-Rise—Volts/Mil at 25°C		D-48-52T	A	250—260	210—240
—Volts/Mil at 100°C		D-48-52T	A	120—170	90—120
[2] Volume Resistivity—Ohms/CM		D-48-52T	C	0.5—5.0 x 10^{11}	0.8—2.0 x 10^{12}
[2] Surface Resistivity—Ohms		D-257-52T	C	0.4—3.0 x 10^{11}	0.8—4.0 x 10^{11}
[2] Insulation Resistance—Ohms		D-48-52T	C	0.2—5.0 x 10^{10}	1.0—4.0 x 10^{10}
[4] Dielectric Constant—60 Cycles		D-48-52T	B	7.7—7.9	8.4—9.4
—1,000 Cycles		D-48-52T	B	7.3—7.5	8.3—8.8
—1,000,000 Cycles		D-48-52T	B	6.7—6.9	7.6—8.0
[4] Dissipation Factor—60 Cycles—%		D-48-52T	B	3.6—4.3	5.2—8.3
—1,000 Cycles—%		D-48-52T	B	2.7—3.1	2.4—3.6
—1,000,000 Cycles—%		D-48-52T	B	2.9—3.1	3.4—4.3
[4] Dielectric Loss Factor—60 Cycles		D-48-52T	B	0.28—0.34	0.44—0.78
—1,000 Cycles		D-48-52T	B	0.20—0.23	0.20—0.32
—1,000,000 Cycles		D-48-52T	B	0.19—0.21	0.26—0.34
[2] Arc Resistance—Seconds		D-48-52T	A	80—100	122—128
[3] Surface Breakdown Ratio		D-48-52T	A	0.43—0.51	0.15—0.23
Rim Arc Resistance—Breaks per Revolution		Cyanamid	A	0—0—0	0—0—0
chemical				
Gasoline (Hi-Oct)—7 Days Immersion at 25°C		Cyanamid		0	0
Lubricating Oil (SAE 20)—7 Days at 105°C		Cyanamid		0	0
1% H_2SO_4—7 Days Immersion at 25°C		Cyanamid		Attack	0
1% NaOH—7 Days Immersion at 25°C		Cyanamid		Discolors	0
1% NaOH—8 Hours Immersion, Boiling		Cyanamid		Attack	Discolors
5% Chromic Acid—4 Hours Immersion at 25°C		Cyanamid		Attack	Sl. Attack
10% Citric Acid—7 Days Immersion at 25°C		Cyanamid		Attack	0
Acetone—7 Days Immersion at 25°C		Cyanamid		0	0

Note: The values above are obtained from laboratory prepared test pieces and may not be exactly reproducible in all cases in commercial practice.

[1] Water is 16.4 Gms/Cu. In.
[2] Consult our Technical Department for details.

CYANAMID

BEETLE®

CYMEL®

Cymel 1500 Wood Fl.-Mel.	Cymel 1502 Alpha-Mod. Mel.	Cymel 3020 Rag-Mel.	Cymel 404 Unfilled	Cymel 592 Mineral-filled	Cymel 3135 Glass-filled	Cymel 3136 Glass-filled
2.4	2.7	10 (5 packed)	2.0	2.4	5—7	3—4.5
Good	Good	Hand only	Good	Excellent	Hand only	Good
40—100 (Extru)	40—100 (Extru)	Medium	Medium	50—100 (Extru)	Medium	Medium
Excellent	Excellent	Very Good	Good	Excellent	Good	Good
310—330	300—330	300—340	300—340	270—340	290—310	290—320
1,500—6,000	1,500—6,000	4,000—8,000	2,000—5,000	1,000—6,000	4,000	2,000—8,000
Excellent	Excellent	Limited	Limited	Excellent	Good	Good
300—330	300—330	———	———	270—340	290—310	290—310
6,000—20,000	6,000—20,000	———	———	4,000—20,000	8,000—12,000	4,000—16,000
0.007—0.008	0.006—0.007	0.003—0.004	0.011—0.012	0.005—0.007	0.002—0.004	0.002—0.004
0.004—0.007	0.001—0.002	0.004—0.008	0.007—0.012	0.002—0.003	0.002—0.004	0.003—0.005
1.5	1.43	1.5	1.48	1.78	1.94—2.00	1.94—2.00
23.8	23.5	24.6	24.3	29.2	31.8—32.8	31.8—32.8
Good	Good	Good	———	Fair	Poor	Poor
32—50 x 10^{-6}	———	———	———	21—43 x 10^{-6}	———	———
8.4 x 10^{-4}	———	10.6 x 10^{-4}	———	13.1 x 10^{-4}	———	———
266	266	310	293	266	400	400
250	250	250	210	300	300	300
Self-Exting.	Self-Exting.	Self-Exting.	Self-Exting.	Self-Exting.	Self-Exting.	Self-Exting.
Discolors	Discolors	0	0	Discolors	0	———
0.34—0.4	0.27—0.28	0.3—0.6	0.3—0.5	0.13	0.09—0.21	0.1—0.2
0	0	0	Good	0	0	0
Fades	Fades	Whites yellow	Good	Fades	———	———
Brown only	Brown only	Limited	Limited	Brown only	Natural only	(Natural Only)
0.26—0.38	0.38—0.41	0.5—0.9	———	0.30—0.41	4.00—6.00	0.5—0.7†
30,000—35,000	———	30,000—35,000	40,000—45,000	25,000—30,000	———	27,000—29,000†
E94	———	E100	———	E90	———	———
10,000—10,500	———	12,000—14,000	———	7,000—8,000	———	———
8,000—10,000	9,000—10,000	12,000—15,000	11,000—14,000	8,700—10,800	10,000—16,000	8,000—9,100†
0.081—0.120	0.091—0.103	0.033—0.132	0.105—0.142	0.051—0.067	0.060—0.072	———
0.7	0.7	0.8	———	0.5	———	———
1.3 x 10^{6}	———	1.85 x 10^{6}	———	1.6 x 10^{4}	———	———
1.1 x 10^{6}	———	1.65 x 10^{6}	———	1.95 x 10^{6}	———	———
5,700—6,500	5,500—6,500	8,000—10,000	———	5,500—6,500	5800	5,000—5,900†
350—370	370—390	320—340	———	410—430	170—240	350—370 (23°C)†
290—330	170—190	110—130	200—210	280—300	90—110	310—350 (50°C)†
240—260	250—280	220—240	———	280—300	170—200	280—300 (23°C)†
190—210	90—100	60—90	———	190—210	60—80	260—285 (50°C)†
240—260	280—290	210—240	———	270—290	170—210	———
170—200	90	70—80	———	170—190	70—90	———
6.0—10.0 x 10^{13}	2.0—3.0 x 10^{13}	1.0—3.0 x 10^{11}	———	1.0—4.0 x 10^{13}	3.0—8.0 x 10^{10}	10—12 x 10^{6}†
0.3—5.0 x 10^{12}	2.0—8.0 x 10^{10}	0.7—7.0 x 10^{11}	———	0.7—16.0 x 10^{10}	0.4—4.0 x 10^{11}	———
1.0—3.0 x 10^{11}	2.0—5.0 x 10^{9}	0.1—3.0 x 10^{10}	———	1.0—4.0 x 10^{10}	0.2—2.0 x 10^{10}	3—6 x 10^{4}†
6.4—6.6	7.0—7.1	8.1—8.6	———	10.2	9.7—11.1	———
6.2—6.4	6.0—6.2	7.4—7.8	———	9.0	8.3—8.7	8.2—7.7†
5.6—5.8	5.6—5.7	6.7—6.9	———	6.1	6.9—7.2	7.2—7.0†
2.6—3.3	12.0—14.0	9.6—11.3	———	10.0	14.0—23.0	———
1.5—1.7	3.9—4.0	4.3—5.0	———	7.4	3.9—5.2	0.023—0.015†
3.4—3.5	3.5—3.6	3.6	———	5.1	2.0—2.6	0.016—0.015†
0.17—0.22	0.8—1.0	0.8—1.0	———	1.0	1.5—2.5	———
0.09—0.11	0.23—0.25	0.32—0.39	———	0.67	0.33—0.45	———
0.19—0.20	0.19—0.21	0.24—0.25	———	0.31	0.14—0.19	———
73—106	71—93	125—128	100—145	135—174	183—186	183—186
0.15—0.19	0.15—0.25	0.15—0.23	———	0.12—0.22	0.14—0.22	———
0—0—0	0—0—0	0—0—0	———	0—0—0	0—0—0	———
0	0	0	———	0	———	———
V. Sl. Attack	V. Sl. Attack	0	———	V. Sl. Attack	———	———
Sl. Attack	Sl. Attack	Attack	———	Sl. Attack	———	———
V. Sl. Attack	V. Sl. Attack	0	———	V. Sl. Attack	———	———
Sl. Attack	Sl. Attack	Attack	———	Sl. Attack	———	———
Attack	Attack	Attack	———	Attack	———	———
Attack	Attack	0	———	Attack	———	———
V. Sl. Attack	V. Sl. Attack	0	———	V. Sl. Attack	———	———

[a] Minimum and average values shown.
[b] Maximum and average values shown.
[b] Tests are ASTM unless otherwise noted. Conditioning procedures follow ASTM D-618-51T
A—40 hours at 23°C, 50% RH. B—48 hours at 50°C, desiccation at RT. C—96 hours at 35°C, 90% RH.
†Mechanical and electrical properties for CYMEL 3136 are determined according to Spec. MIL-M-14E.

CYMAC®

Methylstyrene Molding Compounds

Thermoplastic





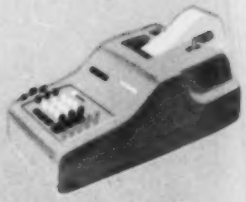
These compounds are so heat-resistant that molded products show no distortion after repeated immersion in boiling water. These thermoplastic compounds may be injection-molded in any equipment designed for their polystyrene counterparts.

CYMAC 400 *Polymethylstyrene*

Offers resistance to heat up to 212°F. plus all the desirable properties of polystyrene: excellent electrical properties, clarity, luster, and unlimited range of transparent and opaque colors. They resist the high operating temperatures encountered in automatic dishwashers, sterilizers, automobile interiors, radios and store display windows. Applications include housewares, hospital equipment, refrigerator trays and containers, nursery products, brush backs and bristles, radio cabinets, battery cells, display fixtures. CYMAC 400 is available in crystal clear, Bureau of Standards colors and an unlimited range of custom colors, transparent and opaque.



CYMAC 201 *Methylstyrene-Acrylonitrile Copolymer*



In addition to the unusual heat resistance of CYMAC 400, CYMAC 201 offers better toughness and an increase in resistance to abrasion, crazing, and attack from chemicals, acids and oils. These characteristics point to picnic and kitchen ware, airline dinnerware, business machine housings, fan blades, packaging, pen barrels. Insert retention is excellent. Available in light straw, ice tint, and an extensive range of transparent and opaque colors.



CYANAMID

CYMAC®

C

properties	ASTM test method	CYMAC 201 heat & chemical resistance	CYMAC 400 heat resistance
Molding Qualities		Good	Good
Compression Molding Temperature—°F		300-375	300-375
Compression Molding Pressure, psi		1000-8000	1000-8000
Injection Molding Temperature—°F		400-550	400-550
Injection Molding Pressure, psi		10,000-30,000	10,000-30,000
Mold Shrinkage, in./in		.0035	.0046
Specific Gravity	D792	1.06	1.03
Specific Vol., $in.^3/lb.$	D792	26.1	26.9
Refractive Index ND	D542	1.559	1.581
Tensile Strength, psi	D638	9,300	6,600
Elongation, %	D638	2.5	2.2
Modulus of Elasticity in Flexure, x 10^5psi		4.6	4.0
Compressive Strength, psi	D695		
Flexural Strength	D790	16,100*	12,900*
Impact Strength ft/lb/in. of notch (½ x ½ in. notched bar, Izod Test)	D256	.40	.33
Rockwell Hardness	D785	83 (M)	76 (M)
Thermal Conductivity, 10-4 cal./sec/cm^2/1°C/cm	C177		
Resistance to Heat, °F (cont.)		210	212
Heat Distortion Temperature—°F	D648	213	215
Vol. Resistivity, ohm-cm (50% HR & 23°C)	D257	2.65×10^{11}	2.63×10^{14}
Dielectric Strength, Short Time ⅛" thick volts/mil	D149	610**	890**
Dielectric Constant, 10^3 cycles	D150	2.92	2.52
Dielectric Constant, 10^6 cycles	D150	2.81	2.48
Dissipation (power) Factor, 10^3 cycles	D150	.0057	.0004
Dissipation (power) Factor, 10^6 cycles	D150	.0078	.0006
H_2O absorption, 24 hrs, ⅛" thick, %	D570	.31	.05
Burning Rate	D65	Slow	Slow
Effect of Sunlight		Yellows slightly	Yellows slightly
Effect of Weak Acids	D543	None	None
Effect of Strong Acids	D543	Attacked by oxidizing acids	Attacked by oxidizing acids
Effect of Weak Alkalis	D543	None	None
Effect of Strong Alkalis	D543	None	None
Effect of Organic Solvents	D543	Footnote (A)	Footnote (B)
Machining Qualities		Good	Fair to good
Color (natural polymer)		Faint yellow tinge	Water white
Clarity		Transparent	Transparent

(A) Attacked by many solvents—gasoline resistant
(B) Attacked by many solvents
* 1 in./min crosshead speed
** 1/16" Disc

LAMINAC®

Polyester Resins

Each of these thermosetting resins has been formulated to provide the best combination of properties for specific applications. With the exception of a few special types, they are clear, nearly colorless liquids. They vary in viscosity, rate of cure, degree of reactivity and in degree of rigidity of the cured product.

Parts can be molded by hand lay-up using a casting technique, or by compression molding with heat and pressure. The reinforcing agent most commonly used is fibrous glass, but a wide variety of fillers can be used—paper, rayon sisal, felt, etc. Flexible or rigid laminates can be produced by the proper choice of resins. Curing temperatures range from normal room temperature to 300°F, while pressures may vary from 0 to 1000 psi.

characteristics

Light weight
Great strength
Impact resistance
Heat resistance
Weather resistance
Abrasion resistance
Corrosion resistance
Excellent dimensional stability
Excellent electrical properties







CYANAMID

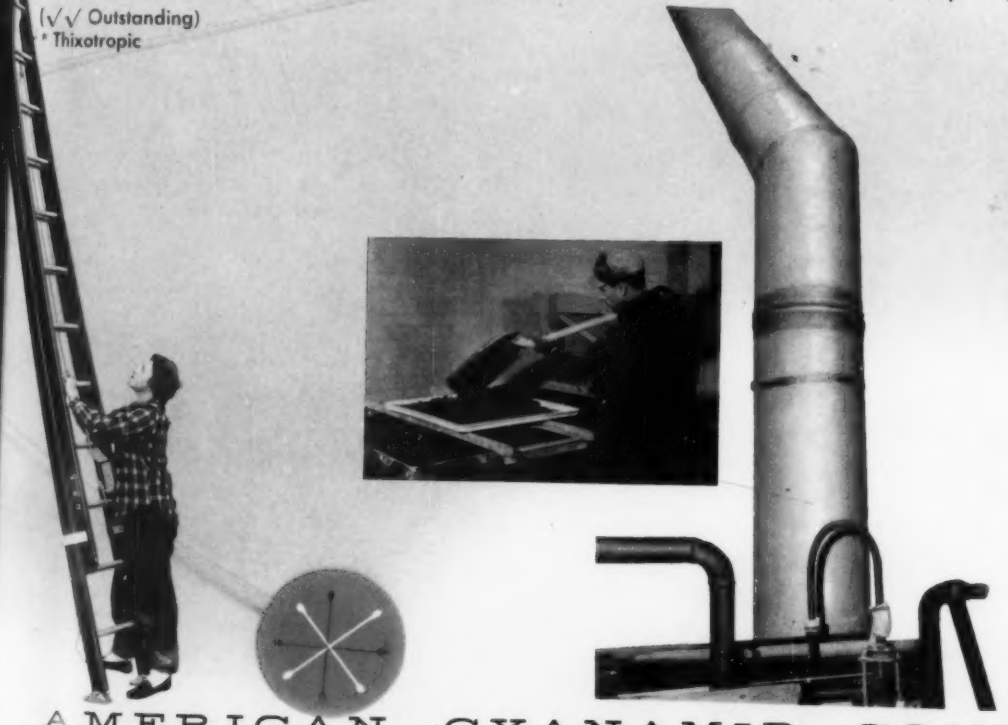
LAMINAC®

d

Properties

LAMINAC® RESIN No.	4101	4102	4109	4110	4111	4116	4119	4120	4123	4128	4134	4146	4192	4202	4232	4233
Viscosity — Low				√	√	√				√	√					
Viscosity — Medium	√		√				√		√			√	√		√	√
Viscosity — High		T*						√						√		
Reactivity — High			√		√		√	√		√		√		√	√	√
Reactivity — Medium		√							√				√			
Reactivity — Low	√			√		√					√					
Cure at room temperature	√	√	√	√	√	√	√	√	√	√	√	√	√			
High modulus of elasticity	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√
Flexible											√					
General purpose molding	√								√	√						
High temperature rigidity			√		√		√	√		√		√			√	√
High heat resistance															√√	√√
Chemical resistance			√		√		√									
Electrical properties			√		√	√	√	√	√	√		√				
Light stability													√			
Fire resistance												√				√
Air-drying		√	√	√	√											

(√√ Outstanding)
* Thixotropic





AMERICAN CYANAMID COMPANY
Plastics and Resins Division

CYMEL®
CYZAC*

Laminating Resins

Thermosetting

For decorative laminates: ***Furniture, counters, wall panels and similar decorative laminates utilize wood veneers, paper or fabric. Impregnation with CYMEL Resins makes them exceptionally hard, strong and resistant to heat, moisture and chemicals.***

For industrial laminates: ***Glass cloth, canvas or asbestos are usually used for industrial grade laminates. Advantages include resistance to heat, flame, electrical arcing, and chemicals, especially alkalis.***



CYMEL 405

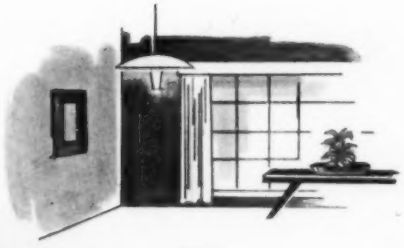
An unfilled melamine-formaldehyde resin in the form of a free-flowing dry white powder. This resin is also suggested for various other uses such as water-resistant thermosetting binders, hardeners for polyvinyl alcohol and polyvinyl butyral, strengthening agent for plaster of Paris, and any other applications that can be aided by the addition of a water-soluble, low-reacted form of heat-setting melamine-formaldehyde resin.

CYMEL 430

Melamine-formaldehyde powdered resin modified with an unusually effective plasticizer or flow promoter. It is used chiefly in treating overlay and print sheets in decorative laminates and exhibits many advantages over the straight or unmodified melamine resins.



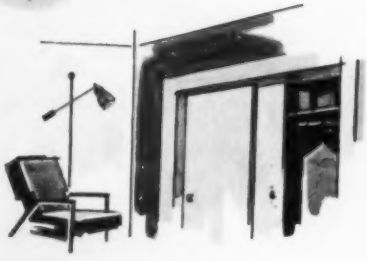
*Trademark



CYZAC Laminating Resins make it possible to produce, directly on low-density particle board and on hardboard-faced plywood, finishes and surface characteristics approaching those of high-pressure decorative laminates. Laminated surfaces produced with CYZAC resins have exceptional craze resistance when subject to heat or strains caused by dimensional changes in the core material. Both resins are solutions packaged at 55% solids content.

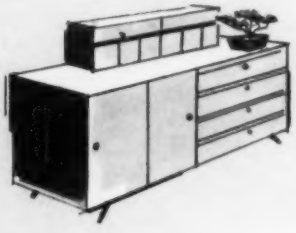
CYZAC 2247

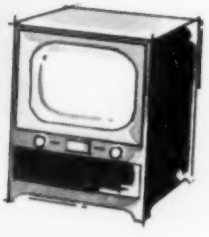
Formulated for impregnating print-grade laminating papers to produce decorative surfaced hardboards for use as wall panels, door panels, cabinets, do-it-yourself applications, low-cost furniture, TV cabinets.



CYZAC 2352

Provides the most satisfactory characteristics in impregnated overlay-grade laminating papers. Laminated directly to wood surfaces at moderate cost, these papers produce a transparent, colorless finish with excellent surface properties; they may even be applied over stained surfaces. The finish gives exceptional beauty and durability to flat working surfaces of tables, dressers, desks and chests. CYZAC 2352 also offers new ease of handling and application in production of prefinished lumber products at lumber mills.





*Trademark

CYMEL®
MELURAC®
URAC®
KETAC®

Adhesive Resins

Thermosetting

CYMEL

NO. 401
Hot press melamine-formaldehyde plywood adhesive for use with or without fillers. May be added to urea resins to improve durability of bond and materially lengthen working life of glue mix. Also used for laminating heavy timbers in marine applications and for general-purpose work where a boil-resistant, non-staining bonding agent is required.

NO. 421
A powdered melamine-formaldehyde resin for use as fortifier of plaster of Paris and gypsum to increase structural strength of cast products.

MELURAC

NO. 255
Powdered melamine-urea-formaldehyde resins, two-package, formulated solely as an adhesive for tapeless splicing of veneers.

NO. 259
Newly developed, one-package, melamine-urea-formaldehyde resin for tapeless splicing of veneers, requiring addition only of water.

NO. 300
Melamine-urea-formaldehyde, one-package, fast-curing colorless powdered resin for hot pressing flat or molded plywood. Combines non-staining, moderate cure temperatures, durability, boil resistance. Ideal for exterior-grade plywood. New catalysts reduce cure rate to that of hot-press urea resins.

NO. 301
Powdered melamine-urea-formaldehyde resin without filler.

NO. 304
A melamine-urea-formaldehyde resin developed expressly for use as a particle board binder. A fine, free-flowing powder that is easily handled. Imparts no color to the particle board. May be blended dry or sprayed from water dispersion into wood chips or sawdust.

URAC

NO. 180
General-purpose, urea-formaldehyde resin in water solutions. Catalysts and hardeners are available for all wood-bonding applications—cold or hot press plywood gluing, high-frequency gluing, fortification of starch-dextrine adhesives, etc. High solids solution (66% P.M.M.A. Method) for drum, tank-car or truck shipments.

NO. 186
Similar to URAC 180, but containing 60% resins solids.

NO. 185
Craze-resistant urea-formaldehyde adhesive for assembly or secondary gluing operations. Two components—liquid resin and powdered hardener. Sets at room temperature with low pressure. Excellent for bonding decorative laminates, Masonite and other hardboards.

NO. 110
Similar to URAC 180, but in powder form containing no inert materials. Catalysts are available for general-purpose wood gluing—cold or hot setting.

KETAC

NO. 1156
A liquid ketone-formaldehyde resin. Alkaline curing, it was formulated especially as a fortifier of starch adhesives used in the manufacture of corrugated paperboard.

gluing-to-standards guide

- ***Commercial Standards CS-35-56***

Hardwood Plywood:

Type I (Fully waterproof bond)
MELURAC 300 . . . Hot pressed (240°-280°F)
CYMEL 401 + 10% walnut shell flour . . .
Hot pressed (240°-280°F)
Type II (Water-resistant bond)
Type III (Moisture-resistant bond)
URAC 110 (Neat powder) Hot or cold pressed with
URAC 180 (Liquid resin) flour extenders

- ***Federal Specification MMM-A-188***

Highly moisture-resistant adhesive for secondary wood gluing:

Type I (Powdered form)
URAC 110 + Hardener 181
Type III (Liquid form)
URAC 180 + Hardener 181
URAC 185 + Hardener 185

- ***Federal Specification NN-P-515***

Plywood Containers:

Type I (Weatherproof)
MELURAC 300 . . . Hot pressed (240°-280°F)
CYMEL 401 . . . Hot pressed (240°-280°)
Type II (Special moisture-resistant)
Type III (Weather-resistant)
Type IV (Non-Moisture-resistant)
URAC 110 (Neat powder) Hot or cold pressed with
URAC 180 (Liquid resin) flour extenders*

**If greater than 100% flour extension, based on resin solids, add preservatives or chlorinated phenol type.*

- ***Military Specification MIL-A-5433A***

Intermediate-temperature-setting Resin:
CYMEL 401 + 10% walnut shell flour

- ***Military Specification MIL-A-5534A***

High-temperature-setting Resin:
CYMEL 401 + 10% walnut shell flour . . . hot pressed (240°-280°F)

- ***Military Specification MIL-P-0066B (SHIPS)***

Plywood, flat panel for boat and ship construction:
CYMEL 401 + 10% walnut shell flour . . . hot pressed (240°-280°F)

- ***Royal Canadian Air Force Specification DTD-484***

Thermosetting Adhesive. Gap filling, cold setting:
URAC 185 + Hardener 185

- ***Joint Army-Navy Specification JAN-P-10***

Fiberboard (V & W Board) Boxes
URAC 180 or 110 to fortify
Starch Adhesive

applications

Plywood and Veneers

Highly moisture-resistant plywood: Urac 110 and 180
Exterior grade hardwood or Douglas Fir plywood (boil-resistant):
Melurac 300, 301, 304, Cymel® 401
Marine grade plywood: Melurac 300, 301, Cymel 401
Tapeless splicing of veneers: Melurac 255, 259

Assembly Gluing

Furniture, sporting goods, millwork, joint assemblies, laminates: Urac 185

High Frequency Gluing

All Urac Resins (with selected hardeners)

Particle Board

Wood particle bonding (sawdust, ground wood, or planer shavings, flakes or other wood chips)
Melurac 304, Urac 186

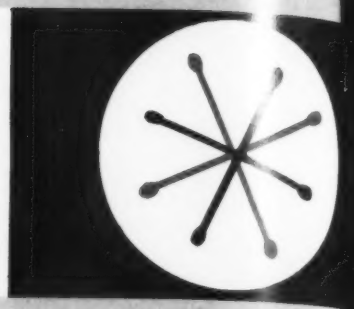
Paper Gluing

Corrugated boxboard, solid fiber laminated board:
Urac 110, 180. Ketac 1156

Fortification of plaster of Paris

Urac 180 Cymel 421

CYANAMID



The data contained herein are based on the best available information and are believed to be correct. However, no warranty is expressed or implied regarding the accuracy of these data, the stability of the product or its use and performance. Nothing contained herein shall be construed to imply the non-existence of any relevant patents nor to constitute a permission, inducement or recommendation to practice any invention covered by any patent owned by American Cyanamid or others, without authority from the owner of the patent.

district offices

Boston 15, Massachusetts
1055 Commonwealth Avenue
STadium 2-6000

Charlotte 1, North Carolina
3333 Wilkinson Blvd.
EXpress 9-0441

Chicago 80, Illinois
3505 North Kimball Avenue
COrnelia 7-6400

Cincinnati 1, Ohio
2350 Glendale-Milford Road
PRinceton 1-5400

Cleveland 14, Ohio
711 Leader Bldg.
Superior and East 6th Street
CHerry 1-1933

Dallas 22, Texas
3709 Atwell Street
FLeetwood 7-1711

Detroit 21, Michigan
10115 West McNichols Rd.
DIamond 1-9142

Los Angeles 54, California
2300 South Eastern Avenue
RAymond 3-6411

New York 18, N. Y.
48 West 38th Street
CIrcle 7-0100

Oakland, California
1440 Broadway
HIghgate 4-5622

Philadelphia 8, Pa.
401 North Broad Street
WAlnut 2-2080

St. Louis 10, Missouri
3025 Pattison Avenue
MOhawk 4-5306

Seattle 9, Washington
550 Mercer Street
Alder 3778

In Canada

NORTH AMERICAN CYANAMID LIMITED:

Montreal, Quebec
5550 Royalmount Avenue
Town of Mount Royal
RIverside 4-2881

Toronto 5, Ontario
160 Bloor Street East
WAlnut 4-9741

AMERICAN CYANAMID COMPANY

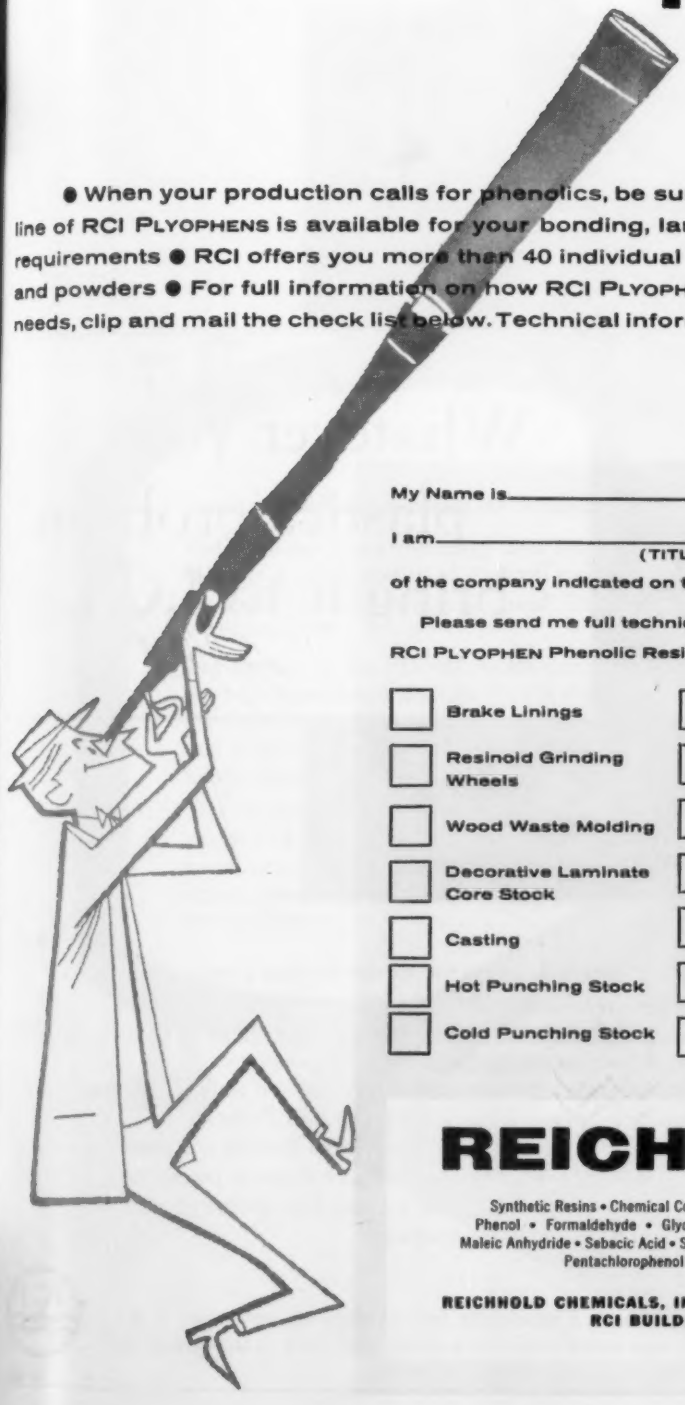
Plastics and Resins Division

30 Rockefeller Plaza, New York 20, New York

TAKE A CLOSE LOOK AT THE FULL LINE OF RCI

PLYOPHEN

PHENOLIC RESINS



● When your production calls for phenolics, be sure you call Reichhold—where a full line of RCI PLYOPHENS is available for your bonding, laminating, impregnating or casting requirements ● RCI offers you more than 40 individual PLYOPHENS—including both liquids and powders ● For full information on how RCI PLYOPHENS can best serve your individual needs, clip and mail the check list below. Technical information will be sent to you promptly.

My Name is_____

I am_____
(TITLE)

of the company indicated on this letterhead.

Please send me full technical information on the use of RCI PLYOPHEN Phenolic Resins for:

- ☐ Brake Linings
- ☐ Resinoid Grinding Wheels
- ☐ Wood Waste Molding
- ☐ Decorative Laminate Core Stock
- ☐ Casting
- ☐ Hot Punching Stock
- ☐ Cold Punching Stock
- ☐ Gear Stock
- ☐ Rolled Tubing
- ☐ Insulation Bonding
- ☐ Plastic Faced Plywood
- ☐ Shell Molds
- ☐ Shell Cores
- ☐ Surface Coating

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives
Phenol • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Sodium Sulfite • Pentaerythritol
Pentachlorophenol • Sulfuric Acid

REICHHOLD CHEMICALS, INC.,
RCI BUILDING, WHITE PLAINS, N. Y.

Creative Chemistry... Your Partner In Progress

RCI



Whatever your plastics problem bring it to I.C.I.

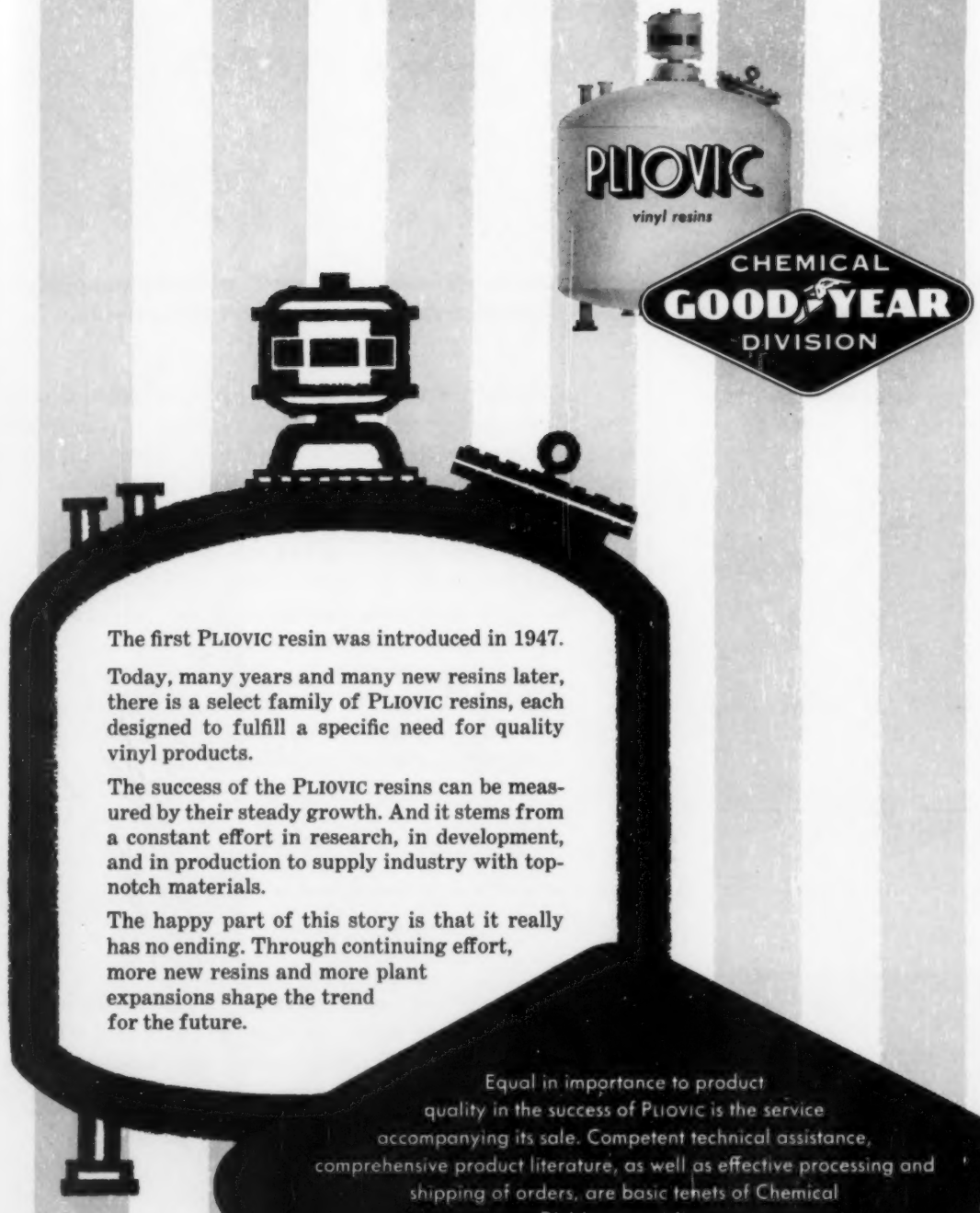
I.C.I WILL HELP YOU CHOOSE the *right* plastics material for the job you have in mind. They will settle any problems you may have concerning suitability, cost and production. When you have decided on the material and the process, they will give you the benefit of their Technical Service which is world wide. From then on it is plain sailing—mainly because stringent technical precautions are taken to ensure that the very high quality of I.C.I. materials *never* varies.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

Plastics Division, Export Dept., Black Fan Road, Welwyn Garden City, Herts.

U.S.A. enquiries to: J. B. HENRIQUES, INC., 521 FIFTH AV., NEW YORK 17, N.Y.
Canadian enquiries to: CANADIAN INDUSTRIES LTD., PLASTICS DEPT., BOX 10, MONTREAL, P.Q.

OP.19/A



CHEMICAL
GOODYEAR
DIVISION

The first PLIOVIC resin was introduced in 1947.

Today, many years and many new resins later, there is a select family of PLIOVIC resins, each designed to fulfill a specific need for quality vinyl products.

The success of the PLIOVIC resins can be measured by their steady growth. And it stems from a constant effort in research, in development, and in production to supply industry with top-notch materials.

The happy part of this story is that it really has no ending. Through continuing effort, more new resins and more plant expansions shape the trend for the future.

Equal in importance to product quality in the success of PLIOVIC is the service accompanying its sale. Competent technical assistance, comprehensive product literature, as well as effective processing and shipping of orders, are basic tenets of Chemical Division operation.

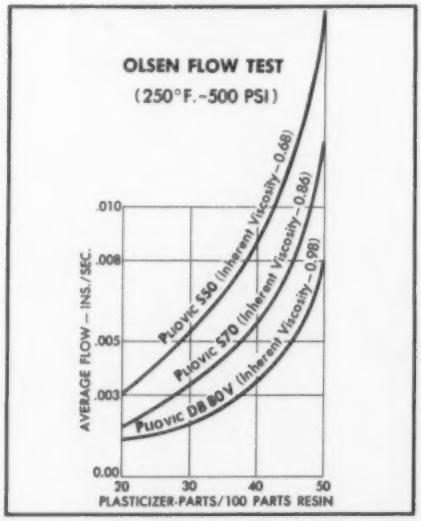
The growing list of PLIOVIC customers indicates it's a good way of doing business, too.



CHEMICAL
GOODYEAR
DIVISION

Two newcomers to the PLIOVIC family:

Two of the latest results of Goodyear's constant development effort are PLIOVIC S50 and PLIOVIC S70. Both meet the processing needs of the industry, without sacrifice of end properties.



Plastic Flow of PLIOVIC S50 vs. Other Vinyl Resins

PLIOVIC S50 is an unmodified polyvinyl chloride resin of very low viscosity. It exhibits many of the desirable processing characteristics of copolymer resins, while approaching the physical properties and heat stability of unmodified, higher molecular weight resins.

Compounds based upon PLIOVIC S50 have superior plastic flow properties, can be processed at temperatures as much as 50°F. lower than average molecular weight resins, and process easily with little or no liquid plasticizers. These advantages suggest the use of PLIOVIC S50 in blends with higher molecular weight resins, as a replacement for copolymer resins or as the base resin in critical molded, extruded or semirigid calendered items.



Crystal-Clear Sheeting Made with PLIOVIC S70

PLIOVIC S70 is a medium viscosity, general purpose, polyvinyl chloride resin. Its viscosity, combined with a fine particle size, is ideally suited to conventional compounding techniques and shows particular advantage in improved flow at moderate temperatures.

The processing advantages of PLIOVIC S70 especially qualify it for use in calendered goods where it exhibits sparkling clarity, excellent surface, good gauge and color uniformity and excellent heat sealability. However, PLIOVIC S70 can also be used to advantage in critical molded and extruded applications or to "temper" high modulus stocks.



CHEMICAL
GOODYEAR
DIVISION

The established members of the PLIOVIC family:

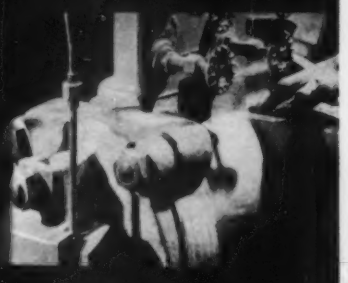
Here are the older members of the PLIOVIC family—resins which through their wide acceptance have proved the worth of continual effort toward improvement in product and service:



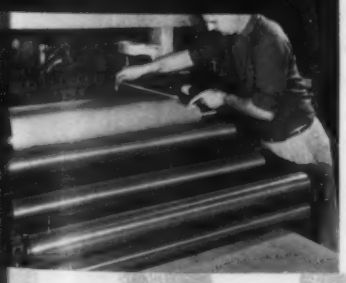
PLIOVIC AO—one of the first of the family—is a unique copolymer with particular application in dispersions. Its fine, soft particles solvate readily, disperse thoroughly with minimum mixing. PLIOVIC AO also tolerates high percentages of extender plasticizers. Moreover, it fuses at low temperatures, providing longer product life through a shorter heat history. Principle applications for this resin include fabric coating, metal coating, and slush or rotational molding.



PLIOVIC DB90V is a high molecular weight polyvinyl chloride as evidenced by its inherent viscosity of 1.09. It possesses the properties characteristic of unmodified vinyl polymers: high strength, a high degree of flexibility when plasticized, full color possibilities, flame resistance, and relative inertness to chemicals, wear, weather and age. The processability and end properties of PLIOVIC DB90V recommend this resin for both extruded and calendered products.



PLIOVIC DB80V is a lower molecular weight polyvinyl chloride resin with an inherent viscosity of 0.98. A general purpose resin, it exhibits properties typical of unmodified vinyls. Where limitations are imposed on processing temperatures, PLIOVIC DB80V allows development of excellent physical properties at somewhat reduced temperatures. Primary application for the resin is in the production of calendered film and sheeting.



PLIOVIC EDB90V is very similar to PLIOVIC DB90V with one important exception—it has passed the rigid tests of Underwriters' Laboratories, Inc., and has been placed on their resin interchangeability list. Thus, PLIOVIC EDB90V combines excellent electrical properties with very good processing and physical property characteristics. It finds application in many types of wire insulation.



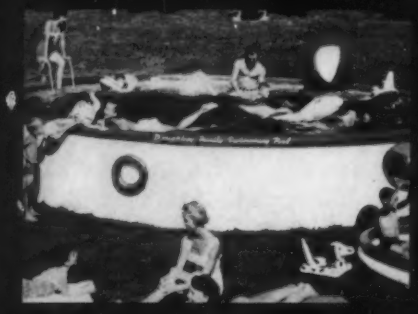
CHEMICAL
GOODYEAR
DIVISION

PLASTICS DEPARTMENT

Typical uses of the PLIOVIC resins:



Coating for Lightweight Tarpaulins—
PLIOVIC AO



Sheeting for Backyard Pools—
PLIOVIC DB80V



Lightweight, Long-lasting Hose
and Tubing—PLIOVIC DB90V



Highly Insulative, Colorful
Wire Covering—PLIOVIC ED890V



Sparkling Clear, Tough
Packaging Film—PLIOVIC S70



High Fidelity Phonograph Records—
PLIOVIC S50

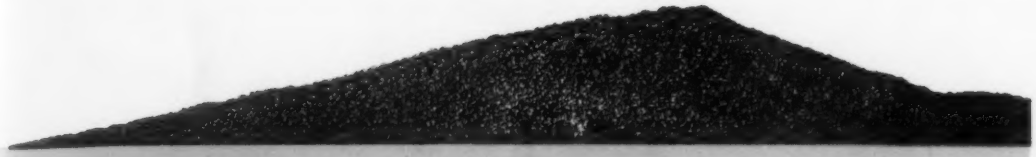
Sources of Service and Assistance on the PLIOVIC Resins:



ATLANTA—Phone: CEdar 4611
BOSTON—Phone: NEedham 3-5850
CHARLOTTE—Phone: FRanklin 5-8973
CHICAGO—Phone: MIchigan 2-8800
CLEVELAND—Phone: CLearwater 2-3000
DETROIT—Phone: WAlnut 1-7900
HARTFORD—Phone: BUtler 9-3424
HOUSTON—Phone: WAlnut 3-5541
LOS ANGELES—Phone: RAymond 3-3611
MINNEAPOLIS—Phone: STerling 9-3551
NEW YORK—Phone: MUrray Hill 6-1300
PHILADELPHIA—Phone: SAgamore 2-8500
PORTLAND—Phone: CApitol 6-2951
ST. LOUIS—Phone: HArrison 9-4000
SAN FRANCISCO—Phone: UNderhill 1-3773

Pliovic—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Listed above are the telephone numbers of the Chemical Division Sales Offices throughout the country. At the one nearest you is the technically trained representative who can help you make the most of the PLIOVIC resins. Feel free to call on him any time for up-to-the-minute information on any of the current PLIOVIC resins or those to come. Or write for details, including the latest *Tech Book Bulletins*, to: Goodyear, Chemical Division, Akron 16, Ohio.

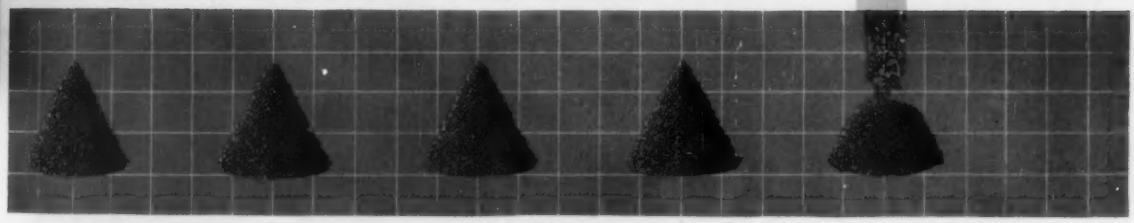


Rogers impact phenolics quality-controlled

FOR AUTOMATIC LOADING

Rogers medium and medium high impact phenolics for automatic molding are the result of a development program with manufacturers of automatic molding equipment. Produced under rigid statistical quality control methods, these compounds feature consistent uniformity in pourability and are so clean as to be virtually dust-free. These advantages are coupled with a fast rate of cure, a low bulk factor of 3.5 to 1 and good to excellent molded appearance.

Uniform apparent density of Rogers impact phenolics for automatic molding assures the right charge every time for automatic volumetric loading or preforming. Absence of dust eliminates arcing during pre-heating. Although created for automatic molding, these Rogers materials offer many advantages for conventional molding techniques. *Write to Dept. PE for data sheets or ask to have one of our technical representatives review our materials program with you.*



Material ideas for product improvement

ROGERS CORPORATION

ROGERS, CONNECTICUT

DUROIDS—for Gaskets, Filters, Electronic Devices, Thermal Insulation, etc. ELECTRICAL INSULATION—for Motors, Transformers, Generators, etc.
SHOE MATERIALS—for Counters, Midsoles, Liners, etc. PLASTICS—Special Purpose Molding Compounds and Laminates RUBBER—for Floats, Grommets, Gaskets, Bearing Seals, etc.
FABRICATING—Including Converting, Combining, Coating, Embossing, and Molding DEVELOPMENT—Research and Engineering of Unique Materials, Parts and Products

adhesives
coatings
sealants

a custom service

typical formulations for **THE PLASTICS INDUSTRY**

number	principal uses	characteristics	color	base	solvent	viscosity	approx. solids	wet weight per gallon	application
ALT-1105	Vinyl to Fabric, leather, paper	Quick grab, high tack with long tack period	White	Natural Rubber	Water	25-30/200 Stormer	47.1%	8.16#	Spray, brush, roll coat
BLG-890-1	Tie coat for vinyl films	Non-blocking; good adhesion to vinyl and elastomeric pressure sensitive masses	White	Synthetic Rubber	Water	15-18/500 Stormer	44.5%	8.90#	Roll Coater —2 mils dry
SW-523	Temporary folding of vinyl	Long tack period and affinity to vinyl; outstanding number in the manufacture of plastic handbags	Creamy Tan	Synthetic Rubber	Toluol, SRS, Ethyl-acetate	17-19" DuPont	17.0%	7.42#	Brush
SB-505	Plastics to wood, metal; aluminum to glass, metal; lucite to steel	Resistant to most plasticizers	Amber	Synthetic Rubber	M.E.K.	12-14" DuPont	29.74%	7.66#	Brush-wet stick, heat or wet activation
SB-545 SB-550	Vinyl tile Rubber tile	Both numbers feature tenacious water resistant bond	Green Green	Synthetic Rubber	Acetone M.E.K.	Trowel Viscosity	60.0%	9.1#	3/32" notched trowel
SBP-568	Plastics to wood, metal	Heavy adhesive designed for knife coating and later activation	Amber	Synthetic Rubber	M.E.K. Acetone Synasol	*20-25,000 Cps. #3 Spindle @ 4 RPM	42.50%	7.67#	Brush, knife coater

*Brookfield RVF Model

special emphasis recently on **ADHESIVES FOR MYLAR***

*MYLAR is DuPont's registered trademark for its brand of polyester film.

Request information on our SB-6300 series for bonding clear or metallized mylar film to itself, to each other or to such substrates as vinyl film, vinyl coated fabrics, paper, metal, rubber, etc.

adhesives for **SANDWICH PANEL CONSTRUCTION**

Request information on our SW-570 series (elastomeric type) for rigid laminating and sandwich panel construction as well as the vinyl phenolic and epoxy types for sandwiches.

Double-Face*

AN ANGIER PRODUCT

PRESSURE SENSITIVE TRANSFER FILM

*Trademark of Interchemical Corporation

A new translucent pressure sensitive mass in film form supported by a release paper which can be either removed at once, or at a later date, for instant bonding of two objects.

also serving every industry with latest developments in

Rubber, Latex and Resin Cements, Pressure Sensitive Cements, Flocking Cements, Laminants, Sealants, Tie Coats and Resin Emulsions.

ANGIER ADHESIVES

Angier Adhesives

Division of Interchemical Corporation

120 POTTER STREET, CAMBRIDGE 42, MASS.

Midwestern Plant: Huntington, Indiana

Ask for more information by series number, by product name, or request Angier's General Folder.

Information desired with inquiry:

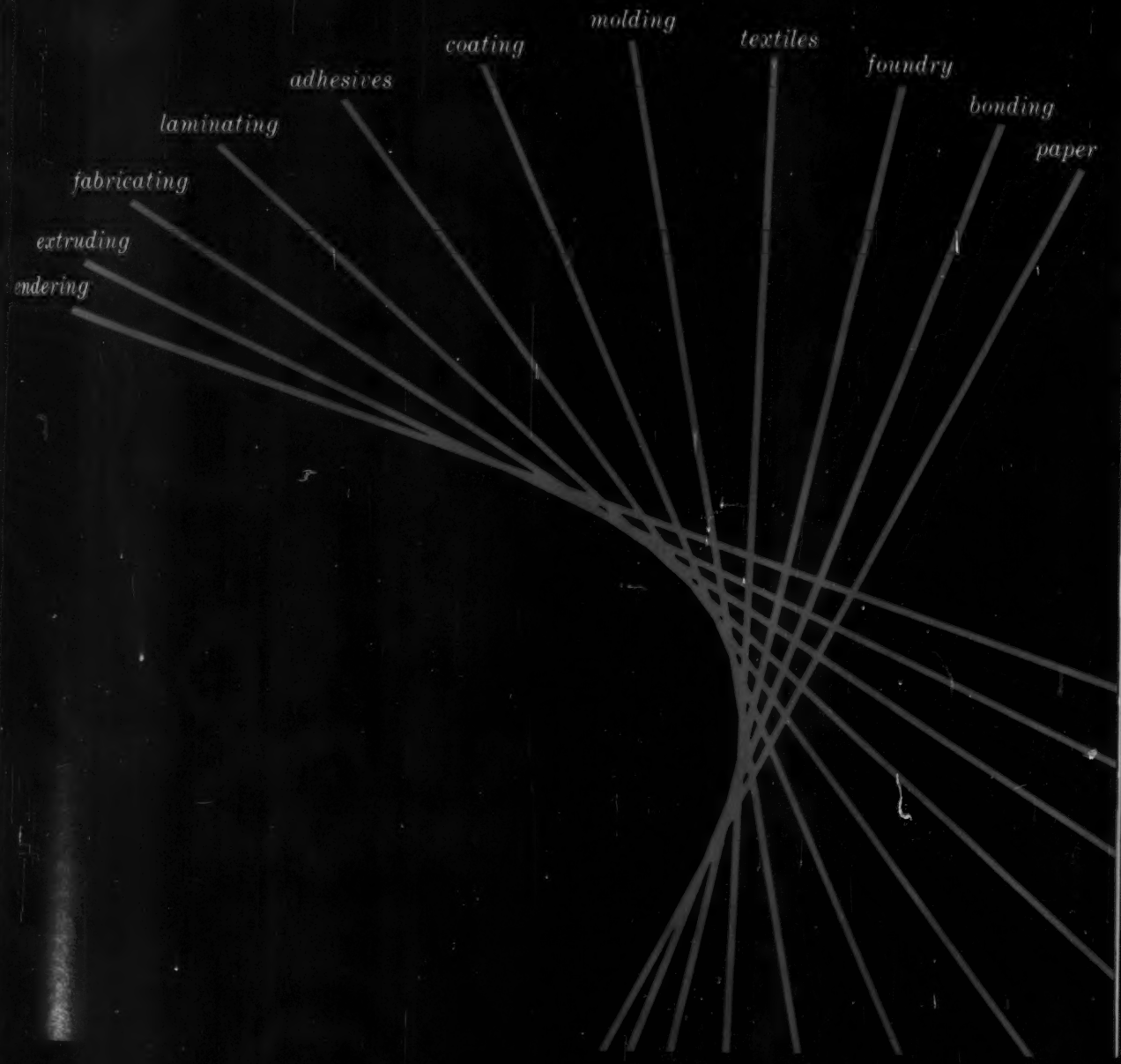
1. Basic materials involved (supply samples when possible). 2. Service requirements involved such as temperature, stress, toxicity, bond strength, use of solvent, color. 3. Assembly requirements, including drying time, design and joint needs. 4. Application preference, such as spray, dip, grid, knife or brush. 5. Estimated volume needed per month. 6. Price limitations. 7. Government specifications or test standard, where in force.

©1957 INTERCHEMICAL CORP.

MONSANTO PLASTICS FACT FILE

MONSANTO

The World's Largest Family of Plastics



MONSANTO MOLDING COMPOUNDS

LUSTREX styrene plastic

Monsanto Lustrex is one of the lightest and most widely used thermoplastic molding materials. It is hard, rigid, with high dimensional stability, good chemical resistance, high dielectric strength, tasteless, odorless, and non-toxic. Lustrex can be molded to sharply defined detail and finish.

Available in a broad range of transparent, translucent, and opaque colors, as well as crystal. Molding compounds for compression, and injection molding, and extrusion in all types of machines and molds. Extrusion formulations suitable for vacuum forming.

There are special formulations in various flows and set-ups: for general purpose applications—the "Balanced Line" comprising Lustrex Hi-Flow 55 (improved flow), Lustrex Hi-Flow 66 (long flow, moderate set-up), and Lustrex Hi-Flow 77 (good flow, fast set-up); rubber modified formulations for applications requiring medium and high impact strengths—Lustrex LHA (medium impact, high degree of translucency), Lustrex Hi-Test 88 (high impact), and Lustrex Hi-Test 88B (extrudable, high impact, high degree of translucency); for applications requiring heat resistance—Lustrex Hi-Heat 99 (heat resistance up to 204° F.), Lustrex Hi-Test 89 (heat resistant, high impact) and LXC, a super heat resistant styrene copolymer with heat resistance up to 217° F.; and for applications requiring fluorescent light stability, all general purpose formulations are available in Lustrex Permatone.

APPLICATIONS:

refrigerator parts
toys
packaging
air conditioner cabinets
radios
housewares
wall tile
phonograph records
television components
displays
electrical equipment









MONSANTO MOLDING COMPOUNDS

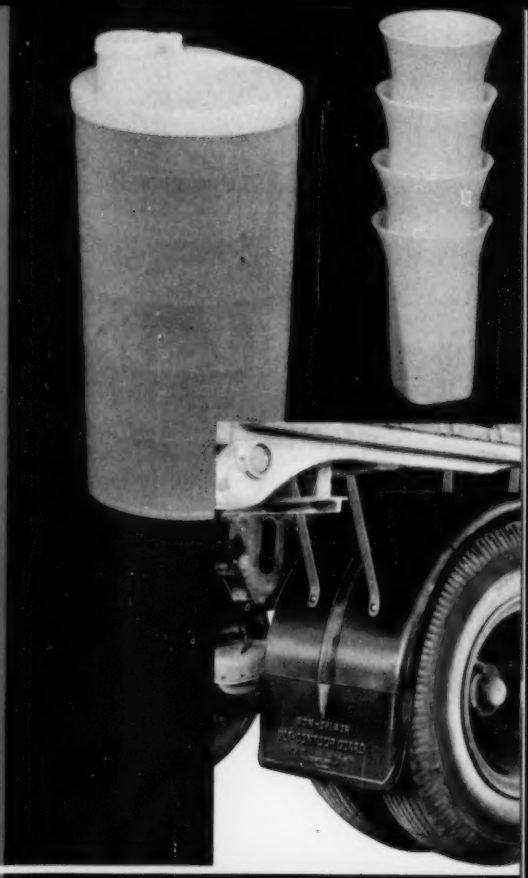
Monsanto *Polyethylene* T.M.

APPLICATIONS:

housewares
toys *packaging*
industrial parts
"squeeze" bottles *vials*
closures
molded liners

One of the newest of the thermoplastics, polyethylene is already one of the most useful and versatile. Polyethylene molded products made from Monsanto Polyethylene resins are tough, resilient, with high impact resistance. They are flexible over a wide temperature range, with extremely low dielectric constant and low power loss factor. They are chemically inert, non-toxic and odorless.

Available in pelleted molding compounds for injection, compression or blow molding over a wide flow range 1.2-22 melt index. Readily processed in a broad range of colors.



RESINOX phenolic

APPLICATIONS:

electrical switch gear
ignition parts for automotive, aircraft, and outboards
TV and radio cabinets
caps and closures *furniture drawers*
appliance components and handles
wiring devices *washing machine agitators*
telephone hand sets *camera parts*
caster wheels
water pump impellers

Monsanto Resinox molding materials are themosetting plastic compounds based on phenolic resin. All molded Resinox parts are characterized by inherent color and finish, resistance to heat, and broad adaptability in design.

A broad range of standard formulations are available for parts requiring high impact and tensile strength, exceptional electrical insulating properties, resistance to high heat, water, acids, alkalis, and other chemicals, or meeting rigid odor and taste requirements.

Six types of Resinox compounds are supplied for compression; transfer or automatic molding: general purpose, impact-resistant, electrical grade, heat-resistant, chemical-resistant, and closure compounds.



MONSANTO MOLDING COMPOUNDS

RESIMENE melamine

APPLICATIONS:

electrical, electronic, and radar equipment
circuit breaker parts *terminal blocks*
connectors *insulating tubes*

Thermosetting molding compounds with cellulose fillers for compression and transfer molding. Recommended for applications requiring high arc resistance, extreme hardness and durability, and excellent resistance to heat and alkalis.



OPALON vinyl chloride

APPLICATIONS:

appliance parts *toys* *masks* *cord plugs*
goggles *coil forms* *knobs*
grommets *sporting goods* *handles* *housings*
swim accessories *wiring devices* *electrical system*
components *housewares* *phonograph records*

Opalon thermoplastic molding powders are supplied in granular form and as dry, free-flowing dustless powders for injection and compression molding. They have outstanding heat stability, moldability, short molding cycles, low shrinkage.



MONSANTO FABRICATING MATERIALS

POLYFLEX* 100

styrene film and sheeting made of Monsanto Lustrex

APPLICATIONS: *packaging printing metalizing decorative laminating overwrapping light diffusers protective laminates signs displays*

Polyflex 100 is a biaxially oriented styrene sheet made of Monsanto Lustrex for use in the manufacture of up-to-date, self-selling packaging, items for the home, decorative laminating and many other applications. Can be blanked, metalized, printed or folded and may be combined with many other materials. Available from stock in roll form in light gauges from .001" through .020" in 21" and 42" widths. Ranges from water clear to opaque with wide variety of color.

*POLYFLEX, T.M. Reg. U.S. Pat. Off. Plax Corp. Licensed to Monsanto Chemical Company



VUEPAK cellulose acetate film

APPLICATIONS: *transparent windows wallet-envelopes fabricated parts filing tabs protective laminates transparent inserts diagrammatic drawings rigid containers displays canisters protective envelopes*

Vuepak is a crystal clear rigid film that can be formed into boxes and containers of outstanding beauty and sales appeal. Available in continuous, untrimmed and slit-to-size rolls up to 60" wide and up to 2000' long, in thicknesses from .005" to .020". Also in stock size sheets.

Vuepak is adaptable to many fabricating methods—shaping, drawing, folding, and scoring. It can be printed, embossed, stapled, or cemented.



NITRON cellulose nitrate film

APPLICATIONS: *optical frames cutlery handles toilet seats hamper tops piano keys*

Nitron is a thermoplastic sheet with exceptional toughness, beauty and pattern variety. It is resilient, but not elastic, resists weak acids and alkalis.

Available in many colors and patterns, Nitron can be fabricated by any standard method—blow-molded, stamped, heat-formed, or machined. It is supplied in 20" x 50" sheets of various thicknesses.

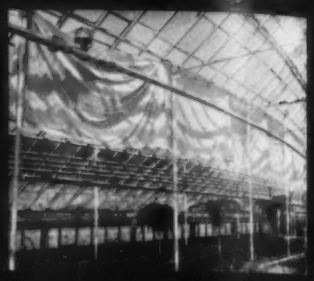


ULTRON vinyl film

APPLICATIONS:

draperies *machine covers*
shower curtains *table cloths*
rainwear *wall coverings*
inflatable items
moisture vapor barriers
laminating





Ultron film is noted for uniform gauge, color clarity, pliability, good drape, and dry resilient hand. It is tough, long-lasting, resistant to mold and mildew, and will not fade or stain easily. Tasteless, odorless, non-toxic.

Available in a wide range of transparent and opaque colors, and in embossed patterns with fabric-like texture and appearance. In gauges up to .020", widths up to 72". Special formulations are available for industrial and agricultural applications.

Ultron film can be heat sealed and cemented, printed, embossed or molded.

ULTRON vinyl sheet

APPLICATIONS:

printing stock *translucent ceilings*
vacuum forming *electrolyte molds*
printing plates *displays*
drawing instruments
light-diffuser panels *calculators*
lamp shades *Christmas lighting displays*



Ultron rigid vinyl sheets and rolls are distinguished for their dimensional stability, mechanical strength and toughness, high softening temperature, flame resistance, excellent light stability, and resistance to chemicals.

Rigid Ultron is available in rolls from .0075" to 0.020", and in widths up to 75"; also in sheets 21½ x 51½" untrimmed in gauges up to 125". Greater thicknesses upon request. Matte, calender, and high polish finishes. Ultron sheets can be printed, die-cut, machined, vacuum-formed, cemented, hot air welded, electronically sealed, embossed, planished, laminated and corrugated.

MONSANTO EXTRUDING AND CALENDERING MATERIALS

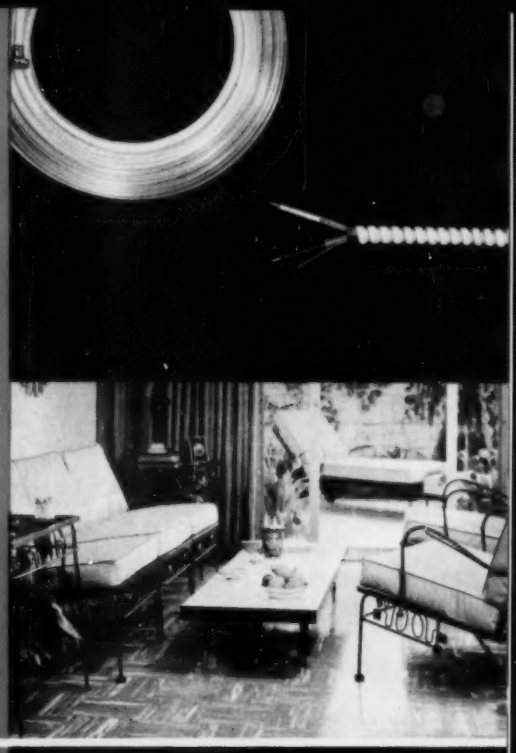
OPALON vinyl chloride resins

Opalon 300, 300FM and 330FM resins are supplied for calendering and extrusion operations and are especially recommended for the dry blending process. They provide exceptional color depth, uniformity, toughness and flexibility at low temperatures.

Special compounds supplied as granules or dry blend for wire and cable insulation, profile extrusion and molding are also available. Excellent for use in the manufacture of rainwear, garden hose, upholstery, fabrics, etc.

Opalon 505 and 510 copolymer resins are widely used in manufacturing floor tile and phonograph records, where ease of processing make these resins particularly suitable.

Opalon 410 is a specially developed paste resin for vinyl plastisol compounding. It is supplied as a "stir-in" powder and increases speed and ease of preparation. Widely used for fabric coating, slush moldings, dipping operations, foams and sponges.

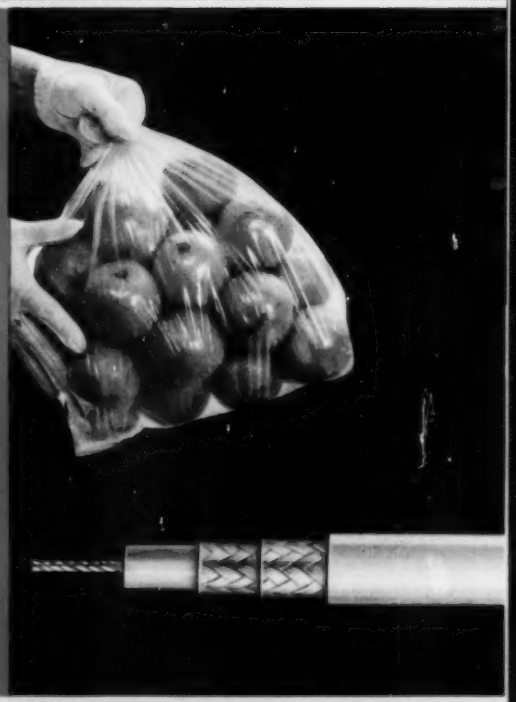


Monsanto

Polyethylene resins

T. M.

In pellets—natural or colored—Monsanto Polyethylene resin may be extruded as film and sheeting, wire insulation, piping, tubing, and profile shapes. Can be calendered into film and sheeting and laminated immediately or in subsequent operation. Non-slip and slip grade formulas available over broad melt index range.



MONSANTO LAMINATING MATERIALS

SAFLEX vinyl butyral

A continuous adhesive film in clear or colored, as well as graduated color, forming the interlayer for laminating safety glass. Also used for TV implosion plate laminates, and decorative applications.



MONSANTO INDUSTRIAL RESINS

for bonding

RESINOX phenolic

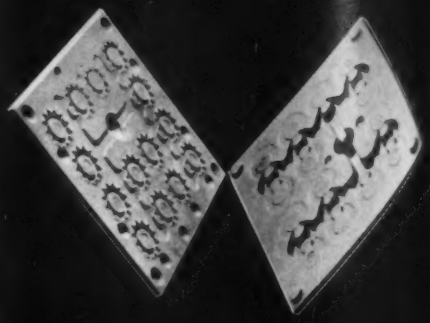
Resinox phenolic resins are widely used as a coating or bonding material for Resinoid grinding wheels, clutch facings, brake linings, coolant and heat-resistant sand paper. Mechanical paper base separators for automotive batteries. Paper and felt base filters for oils and chemicals. Bonding material (with Resimene melamine resin) for glass and rock wool thermal and acoustical insulation and other industrial applications. Available in liquid and dry-powdered form.



for foundry

RESINOX phenolic

Resinox phenolic resins have been specially developed as hot and cold-coating resins for sand in production of shell molds and cores. They are non-dusting, free flowing, with rapid cure.



LYTRON resins

Synthetic resins used as thickening agents in powder form for foundry sand and wash water clarification systems. Lytron reduces clay balling, improves sand workability and packability for better molds for metal castings.

for laminating

RESIMENE melamine

Resimene resins are colorless and color stable, hard, durable, and scratch-resistant, heat and flame-resistant, and chemical-resistant. Available in water-alcohol, soluble, spray-dry powders, they form laminates with paper, cloth, glass and asbestos fibers that provide a beautiful durable surface for all types of furniture, counter tops, cabinets and walls in kitchens and bathrooms. Industrial melamine laminates have high electrical arc resistance and fire resistant properties.



RESINOX phenolic

Supplied in water or alcohol solutions for treating laminate filler materials—paper, cloth, wood veneers, glass, or asbestos fiber. Resinox laminating resins are tough and durable, resist acids and weak alkalis, display good heat resistance up to temperatures of 300-350° F. Used in manufacture of decorative core stock and electrical grade laminates for radio and TV and most home electrical appliances. Also in gears, ball-bearing races, pulleys, bushings, for light and heavy machinery, cars, planes and ships.

ONSANTO TO TEXTILE RESINS

Monsanto supplies a complete line of resins and catalysts for textile finishing and sizing. These provide shrinkage control and washability, lively hand, wrinkle resistance and durability, and improve finish of woolens, cottons, rayons, and other synthetics. Monsanto catalysts speed resin cure so that full effect of resin treatment is obtained.

RESLOOM melamine resins

Series of essentially monomeric melamine resins—liquids or powders. Impart shrinkage control, wrinkle resistance and textural effects to cottons, rayons, synthetics and wools.

RESLOOM E-50 cyclic ethylene urea formaldehyde resin

Supplied as 50% solids cyclic ethylene urea formaldehyde resin in liquid form. Permanent textured effects, dimensional stability, wrinkle resistance or "wash 'n' wear" finishes to cottons, rayons and other synthetics.

LYTRON resins

Unplasticized polystyrene emulsions. Furnish durable finishes without curing or after treatment.

STYMER resins

Stymer LF—vinyl resin soluble in ammonium hydroxide. Stymer S—styrene copolymer resin, soluble in water. Sizes for acetate filament yarns.

CATALYSTS

Four organic catalysts comprise the Monsanto series for textile applications. Provide rapid efficient cure of melamine and cyclic-urea resins to give rayons, cottons and synthetics full effect of resin treatment.



ONSANTO PAPER AND COATING RESINS

Monsanto supplies the paper industry with a line of resins that produce wet strength papers of all types; also resin surface-sizing for improved surface characteristics and excellent printability on various specialty papers and paper board.

OPALON vinyl chloride paste resins

Opalon resins are used in coating cloth and paper. They provide tear strength, low temperature flexibility, and resistance to weathering, aging.

Monsanto Polyethylene resins

As wax reinforcement coatings, Monsanto Polyethylene resins give paper or board coatings a higher gloss, greater scuff resistance, stronger heat seals, improved printability.

SCRIPTITE resins

Scriptite 33 is a melamine-type resin supplied as dry powder and Scriptite 40 is urea type supplied as transparent colloidal solution for creating highly improved wet strength paper. Scriptite 50, 52, and 54 are polyelectolyte resins supplied as dry powder, which dissolved in water, add improved surface characteristics and printability to paper products.



MONSANTO ADHESIVES

A comprehensive list of adhesives that include urea, melamine, phenolic, and resorcinol resins under the trade names of Lauxite and Resinox, and casein and soybean adhesives trade-named Lauxein.

Lauxite and Resinox are recommended as cold-setting adhesives and glues for exterior and interior plywood, furniture. Also used in laminating wood-arches, beams, edge gluing of lumber and door assembly work. Special line for chipboard industries, granulated wood compression molding.

LAUXITE urea and melamine resins

Dry powders and liquids for hot and cold pressing, radio frequency equipment, weather-resistant, quick-setting, high gluing strength.

RESINOX phenolic and resorcinol resins

Dry powders and liquid for cold pressing, hot pressing, and granulated wood molding. Durable water-proof bonds.

LAUXEIN casein and soybean adhesives

Bonding and cold-setting glues for low temperature applications and water-resistant glue bonding. Also used in Monsanto's NO-CLAMP Process for making plywood, doors, lamination work, and many types of wood gluing. For interior type plywood, laminated arches and beams, doors, furniture, cabinet-making, nail-pressure gluing.



MONSANTO INTERMEDIATES

STYRENE MONOMER

Liquid inhibited with TBC. For styrene molding compounds, synthetic rubber, copolymers, ion exchange resins, polyesters; also styrene modified oils and alkyds for surface coatings.

VINYL CHLORIDE

Liquefied gas inhibited with phenol. For the manufacture of polyvinyl chloride resins, compounds, copolymers, and chemical intermediates.

ACRYLONITRILE

Liquid inhibited with Monsanto MQ inhibitor. Uses include production of synthetic textile fibers, nitrile synthetic rubber, copolymers, and chemical intermediates.

FORMALDEHYDE

37% aqueous solution inhibited with methanol. For preparation of melamine and phenolic resins; preservative, disinfectant, and is a chemical intermediate.



MONSANTO SURFACE COATING RESINS

Monsanto supplies a large group of melamine, urea, phenolic, and styrene resins for paints, varnishes, and lacquers. Monsanto also supplies latices for use in the production of interior and exterior paints, and thickening agents for latex paints and compounded rubber latex products.

RESIMENE Melamine and urea-formaldehyde resins in organic liquid solution for baked enamel and industrial finishes. Impart improved soap resistance, surface hardness, faster cure, better gloss, weathering, alkali- and chalk-resistance, color retention to protective finishes for appliances, automobiles, and other fabricated metal items.

RESINOX Phenolic liquid solutions for baked enamels and industrial finishes. Imparts high heat resistance, good chemical resistance for can, drum, and tankcar linings, special primers, chemical resistant coatings, wire coatings.

LYTRON Polyelectrolyte thickening agents in powder form for latex paints and compounded rubber latices. Lytron alkali-soluble resins are used to stabilize, harden, thicken and promote adhesion in water and latex coating systems.

LYTRON Plasticized or unplasticized latices as main vehicles for latex paints and as modifiers in compounding rubber and other latices.



Ask for Monsanto plastics by name:

LUSTREX*
styrene plastic

Monsanto *Polystyrene*
resins

RESINOX*
phenolic

RESIMENE*
melamine

VUEPAK*
cellulose acetate

OPALON*
vinyl chloride

NITRON*
cellulose nitrate

POLYFLEX†
styrene film & sheeting

SAFLEX*
vinyl butyral

SCRIPTITE*
paper finishes

RESLOOM*
textile finishes

STYMER*
sizes

LAUXITE*
adhesives

LAUXEIN*
adhesives

ULTRON*
vinyl film

LYTRON*
synthetic resins

*Reg. U.S. Pat. Off.
†POLYFLEX: Reg. U.S. Pat. Off. Plax Corp.
Licensed to Monsanto Chemical Company

MONSANTO SALES OFFICES:

100 Monsanto Avenue, Springfield 2, Mass.
145 Park Avenue, New York 22, N. Y.
18230 Grand River Ave., Detroit 23, Mich.
7 N. Brentwood Blvd., St. Louis 24, Missouri
McGraw-Hill Bldg., 520 N. Michigan Avenue, Chicago 11, Ill.
427 Hanna Bldg., Cleveland 15, Ohio
6670 East Flotilla Street, Los Angeles 22, Calif.
2710 Lafayette Street, Santa Clara, Calif.
407 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.
911 Western Avenue, Seattle, Wash.
1117 Johnston Bldg., Charlotte, N. C.
Monsanto (Canada), Ltd., 425 St. Patrick St., Montreal, Quebec
Monsanto (Canada), Ltd., 183 Front Street, EAST, Toronto, Ontario

For more detailed information, property specifications and technical assistance on any of the plastic materials described in this brochure, write to Monsanto Chemical Company, Plastics Division, Dept. 1321, Springfield 2, Mass.

MONSANTO®

Where creative chemistry works wonders for you

Engineered Resins
For Modern Industry...

National Polymer Products, Inc. offers you complete service for:



NYLATRON® GS
Nylon Molding Powder

. . . a molybdenum disulphide filled nylon† that is expanding the usefulness of nylon by providing parts with greater rigidity, higher heat distortion temperatures. Molybdenum disulphide — a dry lubricant — adds low surface friction, high wear and abrasion resistance with less warpage and better tolerance control in molding.

† Patents Applied For





NYLASINT® Nylon Powders
for Cold Pressing and Sintering

. . . finely divided nylon powders specially processed with various inert fillers (such as graphite, molybdenum disulphide, etc.) that provide superior properties such as low surface friction and outstanding dimensional stability for bearings, bushings, cams, rollers, gears and similar parts. Cold pressed and sintered Nylasint parts are available through licensees.





WHIRLSINT* Powders

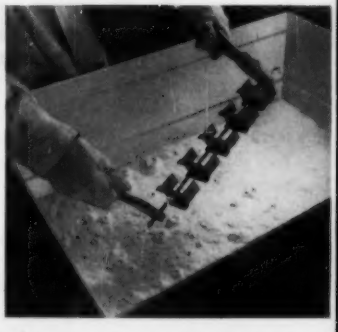
. . . a family of finely divided powders developed for use with the Whirlclad* Process — a new method of applying coatings of resinous materials on metals, glass and ceramics, etc. These Whirlsint Powders consist of:

Whirlsint Nylon
Whirlsint Ethylene
Whirlsint Polyether K-51
Whirlsint Epoxy Resins
Whirlsint Cellulosic Powders
Whirlsint Vinyls

— plus other powders now being tested and evaluated.

The Whirlclad Process is available to licensees in the United States and Canada from Polymer Processes, Inc., an affiliate of National Polymer Products, Inc.

* Polymer Trademarks



National Polymer resins are produced under rigid quality controls to assure consistent, uniform high quality. Write today for detailed performance data or help with your particular application.

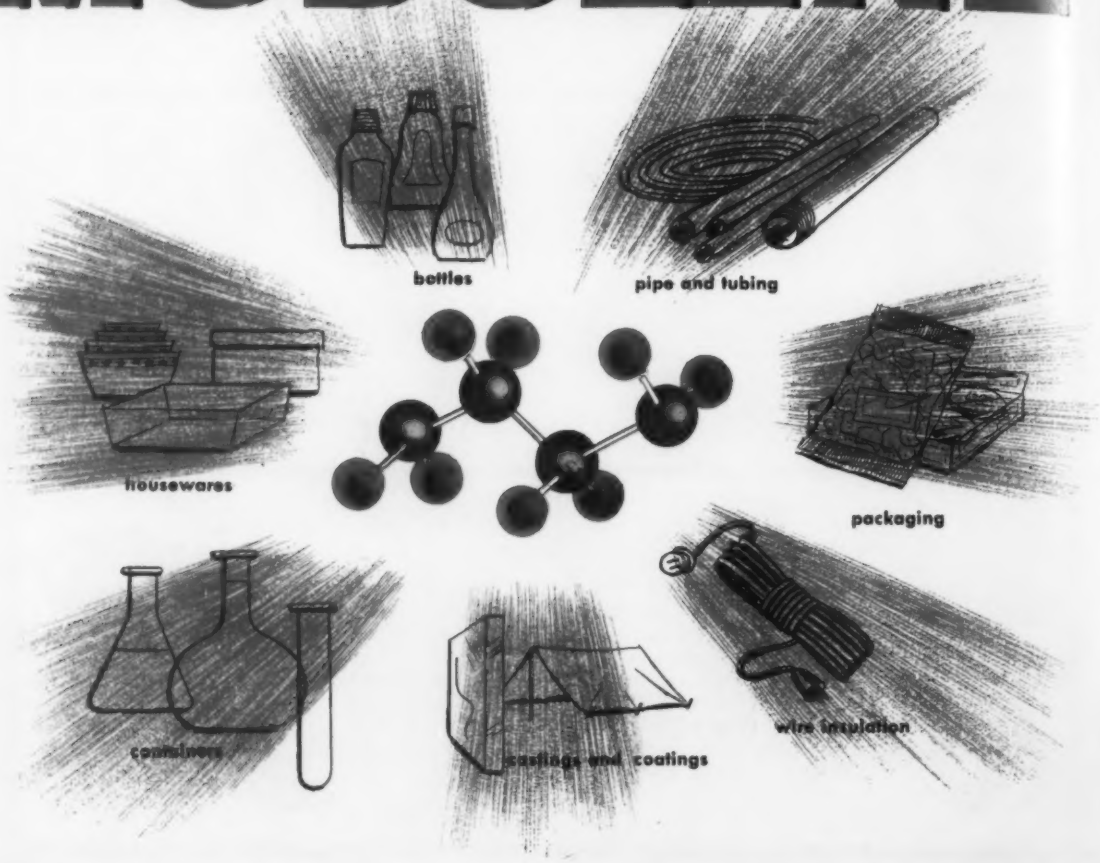
National Polymer Products, Inc.

Subsidiary of The Polymer Corporation • Reading, Pa.

Export: Polypenco, Inc., Reading, Pa., U.S.A.

POLYPENCO

MODULENE*



MAKES IT BETTER!

Whatever you make with polyethylene, Muehlstein's Modulene helps you make it better. For extrusion or injection molding, Modulene's superior properties offer improved product design and lower production costs. It has outstanding low temperature flexibility and toughness, superior chemical inertness, freedom from taste, odor and toxicity, excellent dielectric properties, low specific gravity (.92) and low water vapor permeability. Call on Muehlstein today, and find out how Modulene can improve your product design.

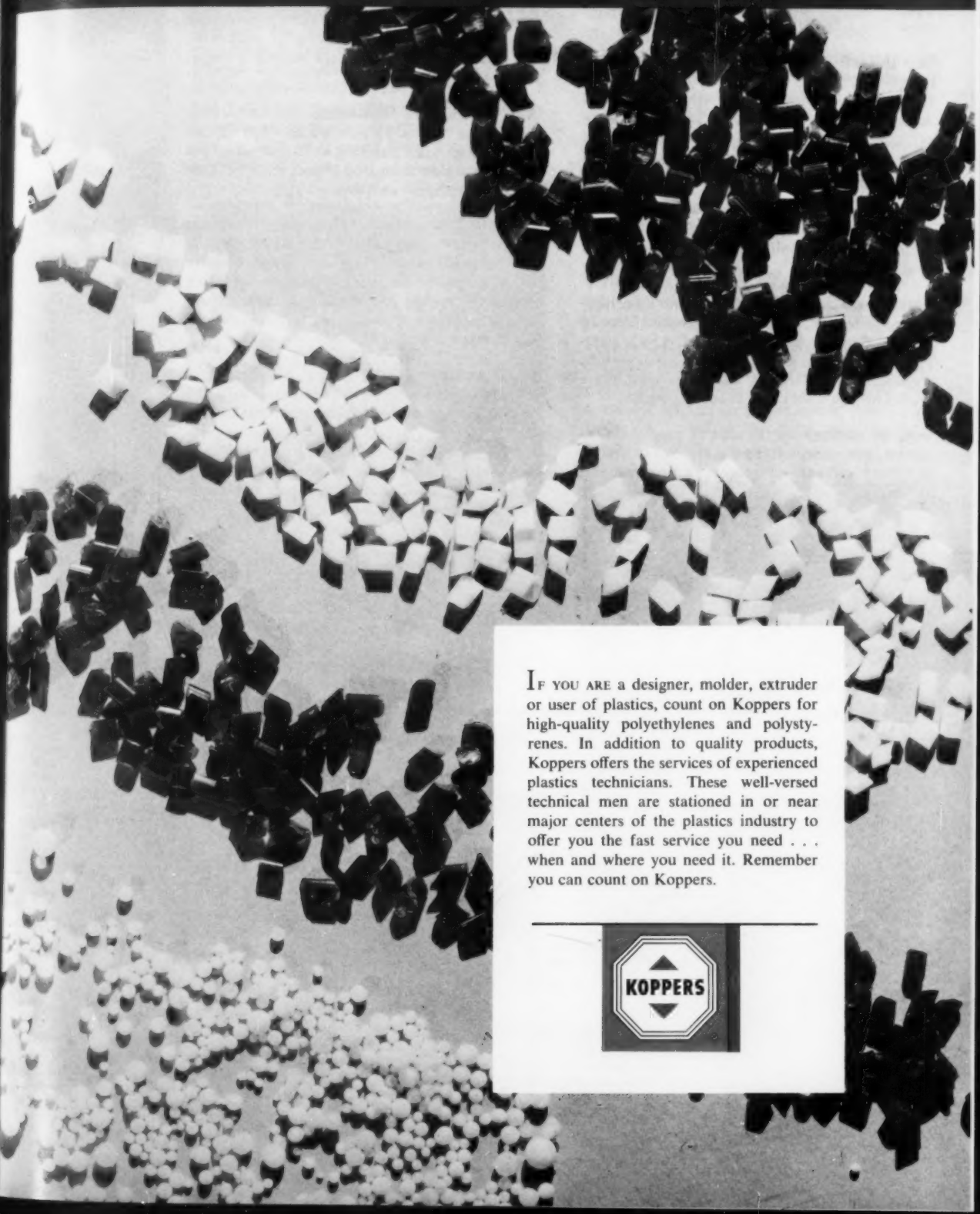
**A Virgin Polyethylene manufactured by Koppers Company, Inc.*

H. MUEHLSTEIN & CO.
60 East 42nd Street, New York 17, N. Y.

REGIONAL OFFICES: Akron • Chicago • Boston • Los Angeles • Toronto • London
PLANTS AND WAREHOUSES: Akron • Chicago • Boston • Los Angeles • Jersey City • Indianapolis

FOUR FINE PLASTICS FROM KOPPERS

- SUPER DYLAN® POLYETHYLENE
- DYLAN® POLYETHYLENE
- DYLITE® EXPANDABLE POLYSTYRENE
- DYLENE® POLYSTYRENE



IF YOU ARE a designer, molder, extruder or user of plastics, count on Koppers for high-quality polyethylenes and polystyrenes. In addition to quality products, Koppers offers the services of experienced plastics technicians. These well-versed technical men are stationed in or near major centers of the plastics industry to offer you the fast service you need . . . when and where you need it. Remember you can count on Koppers.

KOPPERS

SUPER DYLAN® THE POLYETHYLENE WITH MUSCLES

Here's a new polyethylene that loves tough assignments. If you need a plastic that must resist chemicals; have tensile strength; remain tough at low or high temperatures; color easily and yet have a glossy finish and be easy to process . . . choose SUPER DYLAN polyethylene. Here's why . . .

TENSILE STRENGTH. Pipe made from SUPER DYLAN has three times the short-term burst strength of conventional low density polyethylene. 1-inch IPS Schedule 80 pipe made of SUPER DYLAN has tested over 1,000 psi gauge pressure before bursting (at room temperature). A like pipe of conventional polyethylene burst at 350 psi.

CHEMICAL RESISTANCE. Because SUPER DYLAN is an ethylene polymer, it is not attacked by acids (including hydrofluoric acid which dissolves glass) or alkalies.

APPEARANCE AND COLORING. Unlike lower density polyethylene, SUPER DYLAN products have a smooth, glossy appearance. SUPER DYLAN is transparent in very thin sections and has a milky-white, translucent appearance in thicker sections. These factors make a wide range of colors possible.

EASE OF PROCESSING. In spite of toughness, improved heat resistance and rigidity, SUPER DYLAN is remarkably easy to process. In conventional molding machines it molds within the normal range of molding temperatures. It usually requires 50° F. higher cylinder temperature than low density polyethylene and 30° to 50° F. less heat than many impact-type polystyrenes.

HIGH TEMPERATURE TOUGHNESS. At 15 psi steam pressure, SUPER DYLAN samples suffered maximum observable dimensional reduction of only 4%, while conventional polyethylene became a shapeless mass.

LOW TEMPERATURE TOUGHNESS. In comparative tests, SUPER DYLAN bars chilled to −100° F. remained intact when subjected to 32 foot-pound per inch of face blow in an Izod Impact machine. Low density polyethylene snapped.

ENVIRONMENTAL CRACK RESISTANCE. Specimens of low density polyethylene and SUPER DYLAN polyethylene bent to U shape were immersed in an active detergent. Exposure continued for three months. Before the end of this time, all the lower density polyethylene specimens broke, while the SUPER DYLAN remained intact.

MANY APPLICATIONS. Versatile SUPER DYLAN polyethylene is superior for use in the manufacture of toys, kitchenware, auto parts, pipes and fittings, bottles and carboys, packaging films, washing machine agitators, refrigerator parts, battery cases and thousands of other products where strength, improved heat resistance, rigidity, impact and chemical resistance are important.



TYPICAL PHYSICAL PROPERTIES OF SUPER DYLAN POLYETHYLENE

PROPERTY	UNITS	TEST METHOD	RANGE OF VALUES
PHYSICAL AND MECHANICAL			
Density		ASTM-792-50	0.95-0.97
*Tensile Strength†	psi	ASTM-D412-51T (20"/Min.)	3500-5500
		ASTM-638-52T (2"/Min.)	3000-4000
		ASTM-638-52T (0.2"/Min.)	2500-3500
*Elongation in Tension	Percent	ASTM-D412-51T (20"/Min.)	25-100
		ASTM-D638-52T (2"/Min.)	100-400
*Stiffness Modulus	Lbs./Sq.In.	ASTM-D638-52T (0.2"/Min.)	200-Over 700
*Impact Strength, Notched Izod	Ft.Lbs./In. of Notch	ASTM-D747-50	55,000-70,000
Un-notched Izod	Ft.Lbs./In.	ASTM-D256-47T	1-3
Un-notched Izod	Ft.Lbs./In.	At 21°C. (70°F.)	Over 32
		At −73°C. (−100°F.)	Over 32
*Hardness (Shore D Scale)		ASTM-676-49T	63-70
Bulk Factor		ASTM-D1182-54	1.8
ELECTRICAL			
Dielectric Constant (80 Megacycles)		ASTM-D150-47T	2.3-2.4
Dissipation Factor (80 Megacycles)		ASTM-D150-47T	Below 0.0005
Dielectric Strength, Short time	Volts per mil	ASTM-D149-55T	690-740
Step-by-Step	Volts per mil	ASTM-D149-55T	670-700
THERMAL			
Melt Index†	Gms./1p Min.	ASTM-D1238-52T	†
Dimensional Stability	Percent	10 Min. @ 250°F. (Steam)	2-4
*Brittleness Temperature	°F.	ASTM-D746-52T	Below −100°F.
*Deformation Under Load	Percent	ASTM-D621-51 Method-A	
		2000 psi 24/hrs/122°F. Method-B	13-17
		100 psi 3/hrs/122°F.	0.1
*Coefficient of Thermal Expansion	In./In./°C.	ASTM-D696	12.5×10^{-5}
*Mold Shrinkage (Injection)	In./In.	ASTM-D955-51	0.02-0.04

SPECIFICATIONS

PROPERTY	UNITS	TYPE 6200	TYPE 6600	TYPE 7000
*Tensile Strength (2"/Min.)	psi Min.	2800	3600	3600
Melt Index	Gms./10 Min.	1.0-6.0	0.1-1.0	0.1-1.0

**Injection molded specimen.*
†See Specifications.
§Black only, for potable water piping.

DYLITE® EXPANDABLE POLYSTYRENE

This puffable plastic is practical, versatile and strong

DYLITE expandable polystyrene is proving itself as one of the most versatile foam plastics. New uses are constantly being discovered. Product performance has been demonstrated in uses for component parts of refrigerators, buoyancy applications, index packaging, structural panels for housing, pipe insulation, cold storage insulation, toys and display items. Although it's light in weight, its resistance to impact is amazing. Insulation qualities are high while water absorption and vapor transmission are low.

LIGHT YET STRONG. Once DYLITE granules have been expanded in a mold, they form extremely light, yet strong, rigid molded shapes.

IT FLOATS. Because DYLITE plastic floats, it is ideal for making floats, boats, toys and buoys. One cubic foot of DYLITE in a 2 lb./cu. ft. density will easily support 60 pounds in water.

LOW THERMAL CONDUCTIVITY. At 2 lb./cu. ft. density, this foamed plastic has a K factor of 0.22 at 70° F. mean temperature.

WATER ABSORPTION AND VAPOR TRANSMISSION—both low. Since DYLITE plastic has microscopic cells, individual closed cells of the polystyrene keep the water absorption rate low, in fact, less than 0.5% by volume for a 2 lb./cu. ft. density sample. Vapor transmission is only 0.5 to 1.0 grains/hr./sq. ft./inch of thickness/in. Hg. vapor pressure differential.

EASY PROCESSING. DYLITE expandable polystyrene beads can be molded and extended into nearly any shape or form. Subject to heat and pressure, these beads will expand to fill the entire mold cavity. Density is varied by controlling the amount of beads used.



Dylite for slab insulation! Extruded in boards, it can be sawed, drilled, plastered or painted, and cut to specifications with a hot wire. A board foot weighs just 1.3 ounces. Low K factor and good moisture resistance mean excellent insulation.



Fragile items get an easy ride to their destinations when they're packed in Dylite. In addition, the Dylite package makes an attractive point-of-purchase display.



Here's another example of how the low K factor of Dylite really pays off. Ice cubes last longer in this one-piece, seamless Dylite ice bucket that won't sweat or scratch furniture. It's lightweight, practical and durable.

DYLAN® POLYETHYLENES

DYLAN polyethylene is soft and flexible, ideal for squeeze bottles, film and packaging.

DYLAN 3500—Ideal for sheet extrusion and bottle blowing.

DYLAN 3555—Excellent for film blowing.

DYLAN 3700—General purpose and injection molding. Melt index 2.5 plus or minus .5.

DYLAN 3900—Injection molding grade with a melt index of 9 plus or minus 1.0.

DYLAN 4200—Easier flow injection molding. Melt index 17.5 plus or minus 2.5.

DYLAN 4400—Still easier flow with melt index of 22.5 plus or minus 2.5.

Pipe Polyethylenes

DYLAN polyethylene 3000—For potable water.* Only carbon black added.

DYLAN polyethylene 3016—Carb[illegible] black and antioxidant added.*

DYLAN polyethylene 3028—Carb[illegible] black and antioxidant added.*

(Note: Carbon black and antioxidants varied according to customer's reque[illegible])

**National Sanitary Foundation Testing Laboratory at the School of Public Health, University of Michigan, has tested and approved these three* DYLAN *polyethylenes as suitable for conveying potable water supply.*

DYLENE® POLYSTYRENES

DYLENE polystyrene is a rigid thermoplastic readily formed by ordinary methods such as injection molding, extrusion, compression molding, vacuum forming, etc.

Normal DYLENE Polystyrenes

TYPE 2—Ease of molding makes it ideal for use with large and/or small, intricate mold designs.

TYPE 3—Fine molding characteristics make it good for general uses where moderate heat resistance is necessary.

TYPE 4—Use where easy flow and fast setup are of critical importance.

TYPE 7—Excellent general purpose polystyrene with a typical heat distortion temperature of 194° F.†

TYPE 8—Typical heat distortion temperature of 201° F.† is combined with excellent electrical and mechanical properties.

Medium impact DYLENE Polystyrenes

TYPE 30—For appliance parts. Has easy molding characteristics and typical heat distortion temperature of 175° F.†

TYPE 80—Has excellent typical heat distortion temperature of 195° F.†

High impact DYLENE Polystyrenes

TYPE 200—Easy molding and impact resistance make it ideal for large parts such as refrigerator inner door liners, appliance housings, etc.

TYPE 201—Especially designed for sheet extrusions where high luster without overlay is desired.

TYPE 305—For general purposes. Typical heat distortion temperature of 175° F.† and easy moldability are special features.

TYPE 708—Intended for electrical use. Low water absorption for high impact type. Typically medium heat resistance.

TYPE 800—Typical heat distortion temperature of 195° F.† and ready moldability are outstanding features of this polystyrene.

FIBERTUFF® polystyrene (Glass Fiber Reinforced)—For injection molding of strong rigid parts where resistance to distortion by heat or to cold flow are essential. Resists shattering at both ordinary and sub-zero temperatures.

†*ASTM D648*

Fully detailed and illustrated technical folders are available on DYLAN, SUPER DYLAN, DYLITE, *and* DYLENE *plastic materials. They're yours for the asking. If yours is an unusual problem, our staff of technical men are ready to give their help in solving your problems. A call, wire or letter to any of the Koppers sales offices listed below will bring technical information or assistance . . . right to your plant. Count on Koppers.*

KOPPERS

KOPPERS COMPANY, INC.

CHEMICAL DIVISION — **PITTSBURGH 19, PENNSYLVANIA**

EASTERN DISTRICT SALES OFFICE	430 Park Avenue, New York 22, New York *Plaza 5-2810*	DETROIT SALES OFFICE	154 Bagley Avenue, Detroit 26, Michigan *Woodward 3-3396*
PHILADELPHIA SALES OFFICE	355-E Lancaster Avenue, Haverford, Pennsylvania *Greenwood 7-9516*	MIDWESTERN DISTRICT SALES OFFICE	122 S. Michigan Avenue, Chicago 3, Illinois *Webster 9-2400*
NEW ENGLAND DISTRICT SALES OFFICE	250 Stuart Street, Boston 16, Massachusetts *Hancock 6-1700*	TWIN CITIES SALES OFFICE	1000 North Hamline Ave., St. Paul, Minn. *Midway 6-7801*
SOUTHERN DISTRICT SALES OFFICE	1029 Healey Building, Atlanta 3, Georgia *Jackson 4-7620*	KANSAS CITY SALES OFFICE	2023 Walnut Street, P. O. Box 51, Kansas City, Mo. *Baltimore 1-8085*
SOUTHWESTERN SALES OFFICE	4101 San Jacinto, P. O. Box 8188, Houston 4, Texas *Jackson 4-5975*	WESTERN DISTRICT SALES OFFICE	3450 Wilshire Boulevard, Los Angeles 5, California *Dunkirk 8-0678*
PITTSBURGH DISTRICT SALES OFFICE	Koppers Building, Pittsburgh 19, Pennsylvania *Express 1-3300, Ext. 2282*	SAN FRANCISCO SALES OFFICE	55 New Montgomery Street, San Francisco 5, California *Douglass 2-3364*

CANADIAN SALES OFFICE | Dominion Anilines and Chemicals, Ltd., 265 Adelaide St. W., Toronto 1, Ont. *Empire 3-2191*

BARRON PLASTICS

Plastic Sign Letters For Top Visability Signs

A
B
C

The design and brilliance of Barron Plastic Sign Letters make attention compelling, easy-to-read signs. Embossed, rounded letters. Permanent, clean and easy to clean. Use indoors—in windows, shops, offices, factories. Easy to apply and cost less than hand-lettered signs. 1", 1½", 2", 3" and 4"—choice of standard colors. Write for details.



Fabrication -- Molding

Any item fabricated in plastics to your specifications. Custom extrusions. Injection molding of advertising novelties, insignia, plastic parts. Large or small runs at lowest prices.

We can supply your needs, for practically any plastic you want, from one of the most complete stocks in the country. Mill shipments and special orders quoted on request. Butyrate and high impact Styrene sheets for vacuum forming.

ACETATE	SARAN
ACRYLITE EMBEDDED	PHENOLIC
BUTYRATE	POLYETHYLENE
MYLAR	P. V. C.
NYLON	TENITE II
PLEXIGLAS	VINYLITE
POLYSTYRENE	TYGON

Butyrate Tool Handle Stock For Prompt Shipment

Order Eastman Butyrate (Tenite II) round tool handle stock direct from this size and color chart — world's largest stock of assorted sizes and colors. In stock for prompt shipment. 72" lengths.

Diam.	Ambr.	Blk.	Blue	Cir.	Grn.	Red	Wh.
3/8"		V		V			
1/2"		V			V	V	
5/8"	V						
3/4"	V	V	V	V	V	V	V
7/8"	V			V		V	
1"	V	V	V	V	V	V	
1 1/8"	V	V		V	V	V	
1 3/16"	V			V			
1 1/4"	V	V		V		V	
1 3/8"	V			V			
1 3/4"	V						
2"	V						

UNITED Plastics DISTRIBUTORS

J. E. BARRON PLASTICS, INC.
807 SYCAMORE ST.
CINCINNATI 2, OHIO

Write or wire for prompt service.

PLASTIC MATERIALS

WE BUY SELL AND REPROCESS ALL TYPES OF BOTH VIRGIN AND SCRAP PLASTIC RAW MATERIALS

- ACETATE
- BUTYRATE
- ETHYL CELLULOSE
- POLYSTYRENE
- POLYETHYLENE
- NYLON
- VINYLS
- LUCITE & PLEXIGLAS

WE ALSO CUSTOM GRIND AND MAGNETIZE YOUR MATERIALS. YOUR INQUIRIES SOLICITED

M. HOLLAND COMPANY

225 N. RACINE AVE., CHICAGO 7, ILL., TAYLOR 9-6660

WOLOCH for PLASTICS

We Buy and Sell

VIRGIN AND REPROCESSED • MOLDING POWDERS

We carry a large inventory of all types of thermoplastic scrap and virgin molding powders.

Polyethelene • Polystyrene • Butyrate Nylon • Plastisol • Phenolic Cellulose acetate • Ethyl cellulose Vinyl • Acrylic • Plasticizers

george **Woloch** CO., INC.

514 West 24th Street
New York 1, N. Y.
ORegon 5-2350

CABLE: GEOWOLOCH New York

OFFICES:

514 West 24th Street
New York 1, New York
ORegon 5-2350

1587 Water Street
Cuyahoga Falls, Ohio
SWansdale 4-5237

WAREHOUSES:

1082 Norita Street
Akron, Ohio

1587 Water Street
Cuyahoga Falls, Ohio

432 First Street
Jersey City, New Jersey

601 West 26th Street
New York, New York

514 West 24th Street
New York, New York

Reprints of articles, features and advertisements that appear in this publication are often surprisingly inexpensive when ordered in quantity. Many companies make it a practice to have stories which have a bearing on their business reprinted for distribution to their own personnel, customers, prospects, stockholders or to other interested groups.

make profitable use of

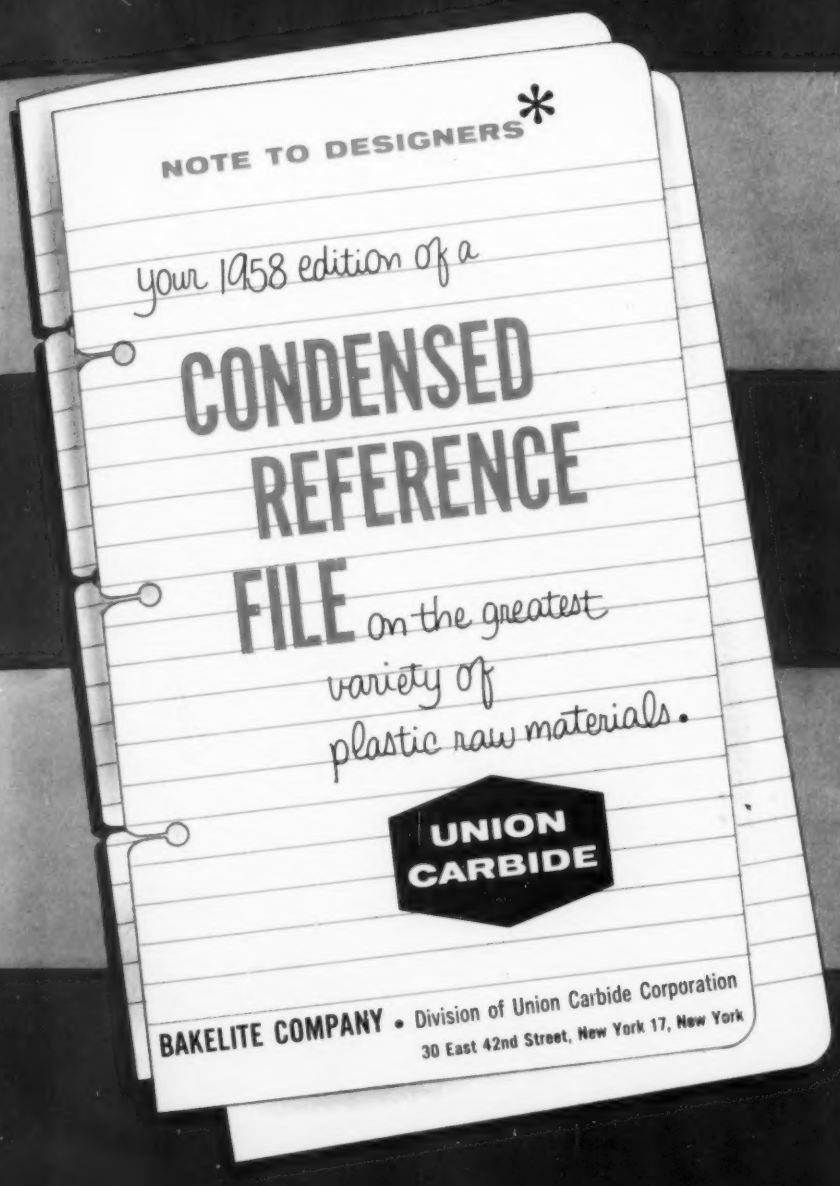
REPRINTS

If, at any time there is or has been something in Modern Plastics magazine or the Encyclopedia Issue which you can use in reprint form, in quantities of 100 copies or more, write and quotations will be furnished promptly.

INDUSTRIAL MAGAZINE SERVICE

An Affiliate of Breskin Publications

575 Madison Avenue New York 22, N.Y.



*** A WORD ABOUT PLASTICS**

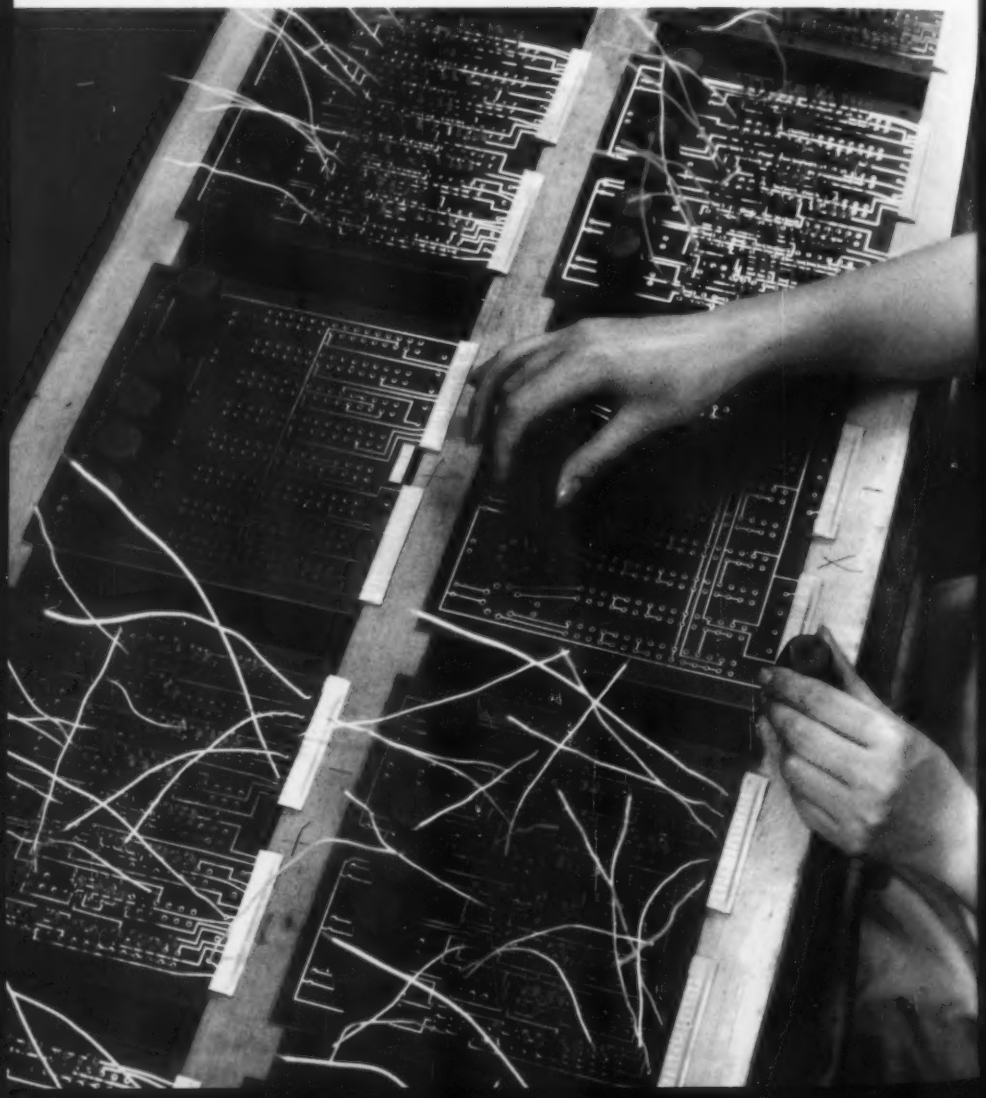
Each plastic group is **defined** by a chemical formula and should be **confined** to evaluated areas of application. Properly evaluated, plastics serve an essential role both as primary and as complementary raw materials. This proper evaluation demands the co-operation of the raw materials' supplier, the fabricator, the designer and the engineer.

PHENOLICS

THE PIONEER PLASTIC

The plastic industry, as it is known today, began at the turn of the century with the development and almost immediate commercial use of BAKELITE phenolic plastics. The use of phenolic materials expanded as other industries such as radio and transportation grew during the first half of the twentieth century. In this continuing path of progress, phenolics served as the catalyst for some of these industries so that today it might be said that phenolics are essential to our national economy. The phenolic resins marketed by Bakelite Company are generally classified as molding materials, bonding and laminating resins, and coating resins. Over the years, general-purpose phenolics satisfying a wide variety of uses have been developed. However, as is true of all plastic materials, phenolics can be formulated to meet specific requirements.

Essential to the success of the printed circuit was the development of insulating base materials with the proper electrical properties. Bakelite Company was instrumental in providing a phenolic laminating resin that met critical specifications — this material is now accepted as standard throughout the industry.



in particular, phenolics offer...



molding

STRENGTH — Phenolics harden into an infusible state. Many applications of phenolic, such as this washing machine agitator, evidence remarkable impact, tensile and flexural strengths — rigidity and dimensional stability.



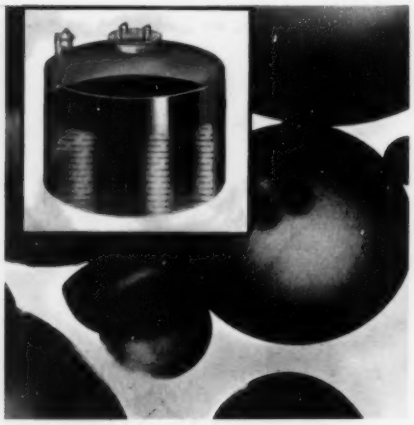
coatings

DURABILITY — Important in all applications, phenolics not only protect but also endure. For sixteen years, phenolic based coatings have protected this bridge.



bonding

HEAT RESISTANCE — Phenolics are available that will withstand temperatures as high as 400 deg. F. for long periods of time, even as much as 500 deg. F. for shorter periods. Heat stability is an all important property in phenolic-bonded abrasive grinding wheels.



evaporation control

VERSATILITY — Millions of microscopic hollow phenolic spheres serve as a floating blanket to cut evaporation losses in crude oil storage tanks.

Copyright 1957 by UNION CARBIDE CORPORATION.
The terms BAKELITE, KRENE, and UNION CARBIDE are registered trade-marks of UCC.

VINYLS

VERSATILE VINYLS

First produced on a commercial scale by Carbide and Carbon Chemicals Corporation, another division of Union Carbide Corporation, vinyls today perform vital services in almost every branch of industry and home life. The ever increasing application of BAKELITE vinyls has been paced by the development of newer and improved vinyl resins and compounds. These developments improved established applications and made possible others which before may only have existed on the designer's drafting board. Bakelite Company produces the world's largest variety of vinyl raw materials. For this reason, we can supply vinyl materials to conform to almost any requirement and to meet successfully a wide range of demanding specifications.

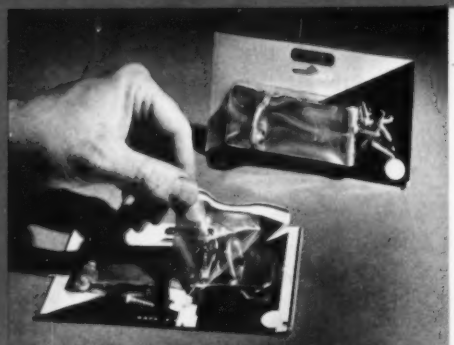
Vinyl gives an application the "handmade" look plus ruggedness and long service life. Extruded luggage bindings give that type of service — toughness and abrasion resistance. Calendered vinyl is also used extensively for luggage covering.



cases in point...

skin packaging

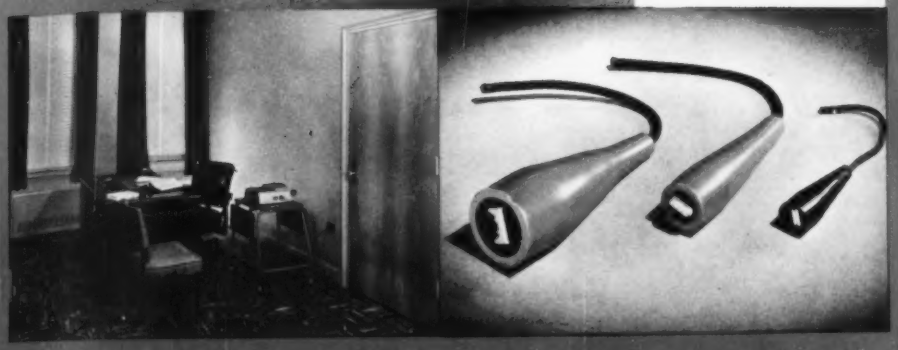
STRENGTH AND CLARITY — KRENE cast vinyl film is indispensable for the new skin packaging technique — crystal clear film is vacuum formed around saleable items securing them to appropriate merchandising cards.



vacuum forming

COLORFUL AND PRINTABLE — Rigid vinyl sheets can be pigmented in a wide variety of colors and multicolor printed to provide attractive designs and patterns.





calendering

PARTICULARLY VERSATILE — Rigid or flexible, transparent or opaque, whatever the application requires. The walls, floor and upholstery in this office are covered by appropriate types of calendered vinyl.

molding

ELECTRIC RESISTANCE — Remarkable insulating properties plus greater durability make electric insulation practical — as evidenced by the vinyl insulation on these terminal clips. Vinyl withstands abrasion and rough handling and can be formulated to give exceptionally high flexibility.

coatings

CHEMICAL, WATER AND ABRASION RESISTANCE — Vinyls are compounded for extreme chemical inertness, and for resistance to water and abrasion. An extremely fast drying, easily applied vinyl resin paint system has given effective protection against corrosion and abrasion on these Mississippi dam gates for eight years.



STYRENE

THE STYRENE STORY—
DEPENDABLE and FUNCTIONAL

In the quarter century that styrene has been on the commercial scene it has become recognized as one of industry's most versatile plastics. Styrene can be found in applications ranging from toys to battery cases and from brushes to refrigerator door liners. This is quite plausible since modifications in the basic styrene resin and its copolymers have resulted in compounds that offer varying degrees of impact, heat and chemical resistance. Modifications offer a wide range of properties and colors to meet the growing demands of an ever-broadening consumer market — demands which translate as a variety of product specifications that BAKELITE styrene helps you to satisfy. These compounds are available in an almost unlimited range of colors which may be transparent, translucent or opaque.



Styrene offers beauty. Color, gloss and smooth finish are features of these styrene flower pots. These are properties common to styrene compounds. Pigment dispersion is so thorough, color is an integral part of the finished product.

styrenes have much to offer... for example...



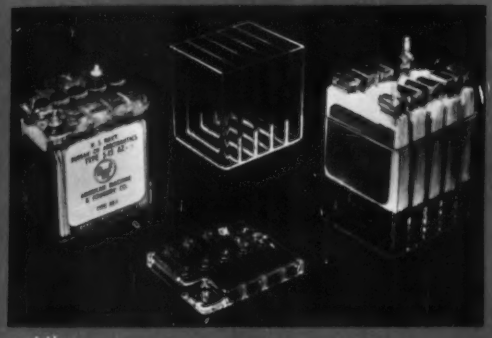
extrusion

VERSATILITY AND DURABILITY — Long lasting brush bristles — extruded styrene monofilaments.



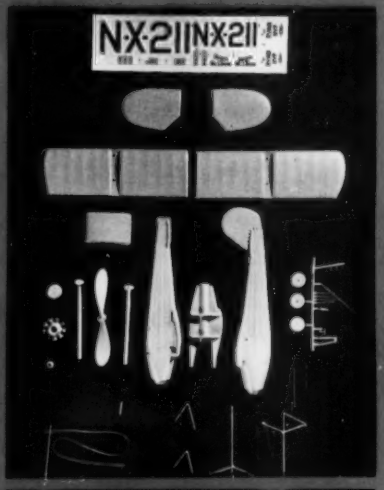
extrusion

IMPACT RESISTANCE — Strength, even in thin sections, afforded by BAKELITE Brand impact styrene makes these dishes and trays a useful addition to the modern kitchen. Note superior gloss!



molding

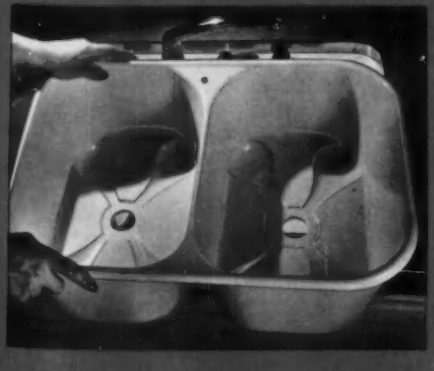
CHEMICAL RESISTANCE — Styrene products withstand the attack of salts, acids and alkalies. For more demanding applications, a styrene copolymer material, C-11, was developed to offer additional resistance to soaps, detergents, fats, kerosene, various solvents, oils and even battery acids.





vacuum forming

FORMABILITY — Ease of formability ensures uniform production rates essential to mass production assembly lines. This intricate toy plane, vacuum formed from extruded styrene sheet, indicates the facility with which the material forms.



extrusion

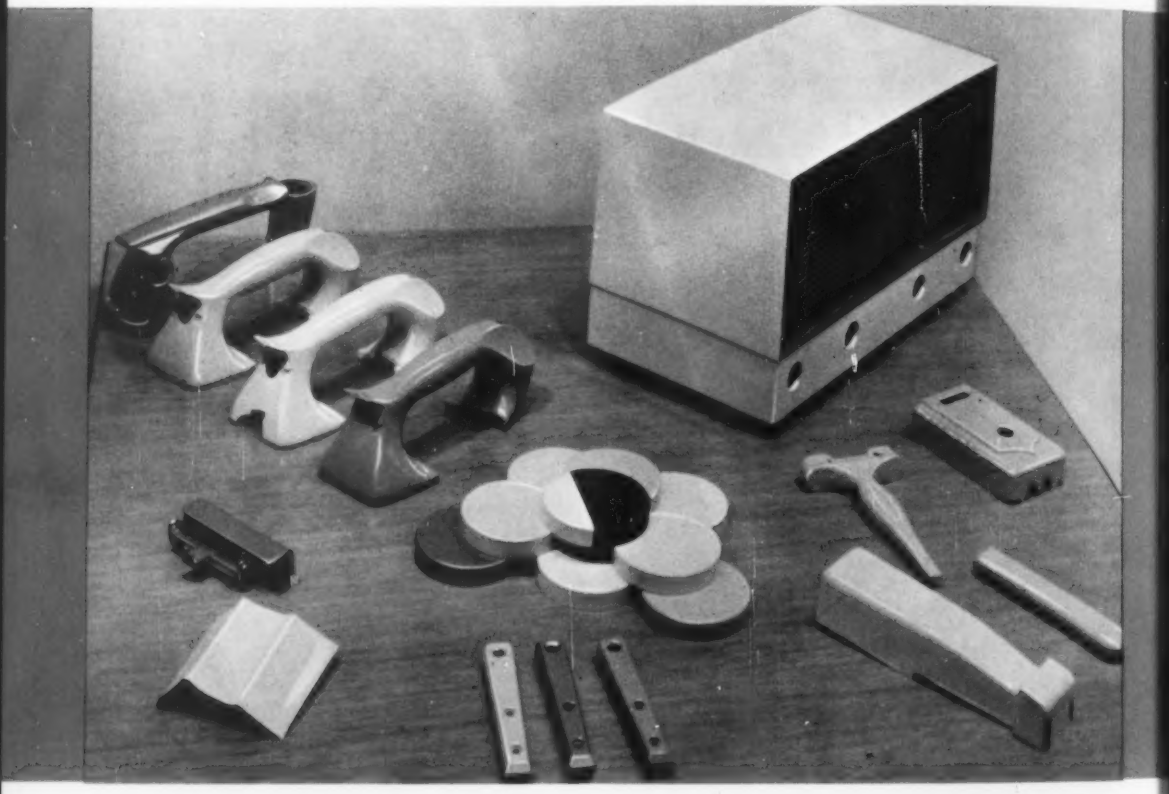
HEAT RESISTANCE — For applications requiring a high heat resistance, Bakelite Company offers a specially formulated styrene with an ASTM rating of 197 degrees Fahrenheit. Dual sinks fabricated from extruded styrene sheet have been very successful in resisting the effects of hot dish water.

EPOXIES

IN TEN SHORT YEARS...

Epoxy resins have exhibited one of the most impressive growth patterns of any newly developed plastic. An excellent combination of outstanding properties accounts for their quick acceptance and wide range of uses. In applications such as: surface coatings, potting and encapsulating of electronic and electric assemblies, tooling compounds, plastic laminates and adhesives, the outstanding properties of epoxies are dramatically demonstrated. For instance, in tooling, epoxies have resulted in substantial time, labor and money economies. As a basic raw materials supplier, Bakelite Company markets epoxy resins to a broad segement of industry.

epoxy resins exhibit

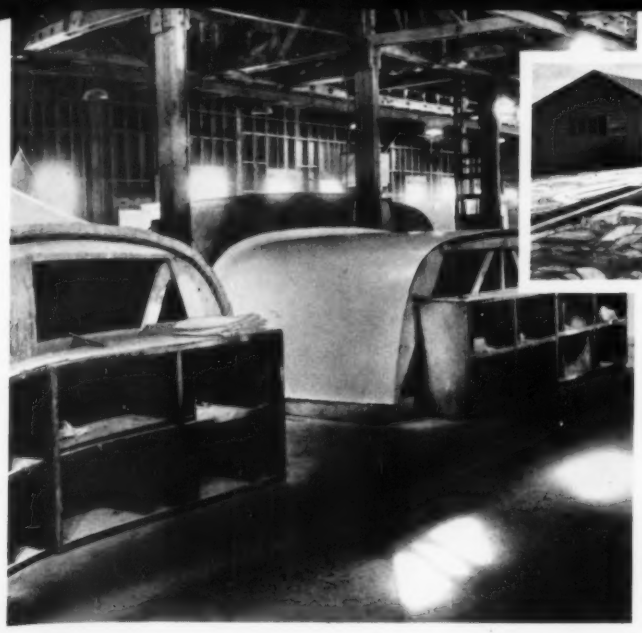


A coating based on BAKELITE epoxy resins — color now where there was no color.



bonding

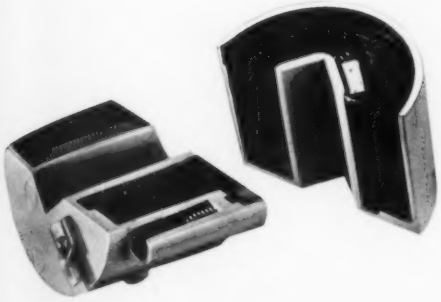
ADHESION — Ability of epoxies to bond such products as ceramics, glass, aluminum, ferrous metals, wood, most plastics and rubber, enhances the serviceability of these materials in many fields.





bonding

VERSATILITY — The various sections of the pool are formed from these giant molds made with a compound based on epoxy. This glass fiber-reinforced plastic swimming pool presents a relaxing scene that belies the careful, detailed design involved in its production.



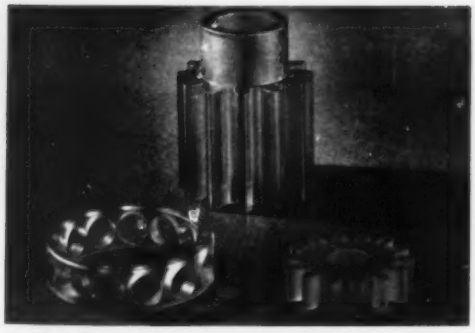
potting

ELECTRICAL PROPERTIES — This coil demonstrates superior dielectric strength. Working life is extended and efficiency is improved when assemblies are protected by epoxy resin.



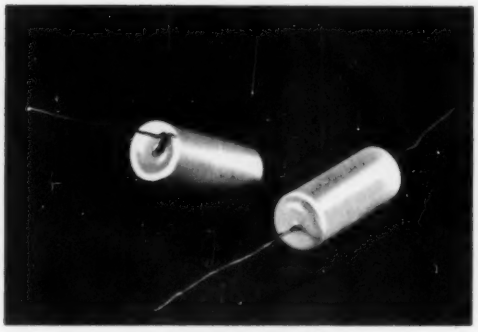
body solders

CURING ADVANTAGES — Cured at room temperature glass cloth-epoxy fender patch reduces cost 70 per cent.



casting

DIMENSIONAL STABILITY — Not only do premium parts cast from epoxies ensure close tolerances in reproduction but also maintain this accuracy throughout the life of the component.



encapsulating

CHEMICAL, MOISTURE AND FUNGUS RESISTANCE — Epoxies resist corrosion, most chemicals, fungus and moisture penetration. Electronic capacitors encapsulated in epoxy are assured substantial increase in service life.

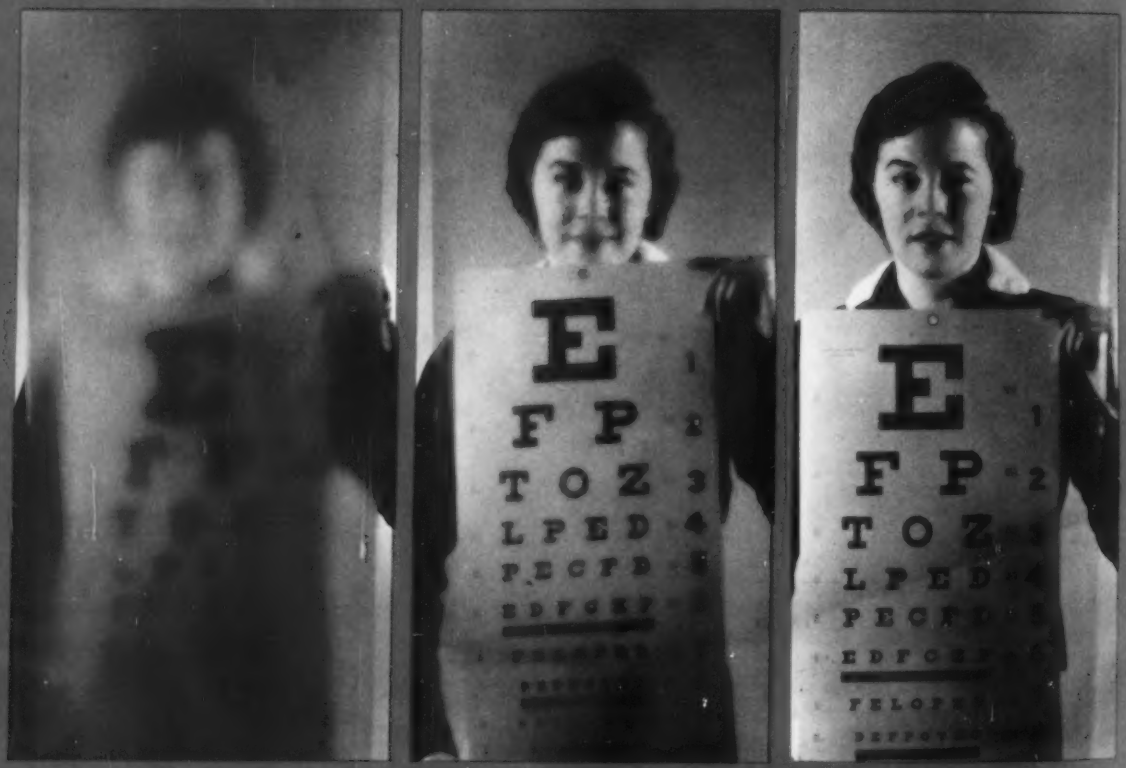
POLYETHYLENE

A NEW LOOK AT POLYETHYLENE

First in production, first in quality and first in performance summarizes the role of BAKELITE polyethylene in the plastics world. As early as 1943, when polyethylene was first used as high frequency insulation on Navy radar, Bakelite Company was a pioneer in the development of this history making material. Today, our laboratories are not only actively engaged in maintaining and improving the qualities of our resins but are also discovering new and better production techniques which will expand the fields of application for this key plastic material.

Design engineers, the world over, have found polyethylene an invaluable and essential item for these reasons . . .

These photographs dramatically illustrate the progress made in developing excellent optical properties in polyethylene film. Through the constant effort of research and development, Bakelite Company continues to offer film extruders a wide range of polyethylene resins and compounds. The films made from these compounds can be used, creatively, to satisfy a variety of packaging requirements, thereby helping users to increase sales.





molding

FLEXIBILITY—Polyethylene is flexible without plasticizers, case in point, molded squeeze bottle. This plastic will retain inherent flexibility over a wide temperature range.



extrusion

ELECTRIC RESISTANCE — Superior low-loss electrical properties of polyethylene recommended it for the major insulation material on this — the first transatlantic telephone cable.



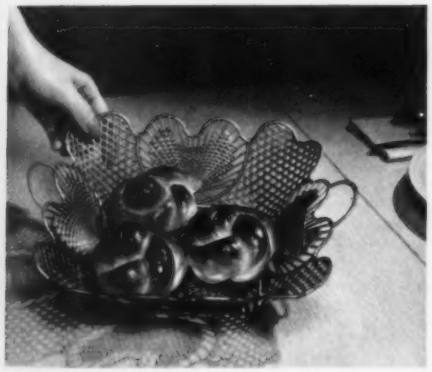
calendering

MOISTURE RESISTANCE — This calendered, embossed tablecloth is tough and flexible, and resistant to most household fluids. It stands up under daily multiple washings. Color is an integral part of the finished product — it can not scratch or wash off.



packaging

VERSATILITY — Polyethylene has high tear strength, extremely low moisture-vapor transmission, is odorless and tasteless. Its permeability for both oxygen and carbon dioxide permits perishables to **breathe,** thus prolonging their preservation. This is evidenced by the wide acceptance of polyethylene packaged foodstuff.



molding

FORMABILITY — A free flowing thermoplastic, polyethylene can be formed in myriad shapes and sizes. One example — this intricately designed basket was injection molded.



extrusion coating

CHEMICAL RESISTANCE — Polyethylene coats the inner surface of this package. The chemical inertness of polyethylene is utilized here to preserve the high purity of research grade chemicals.

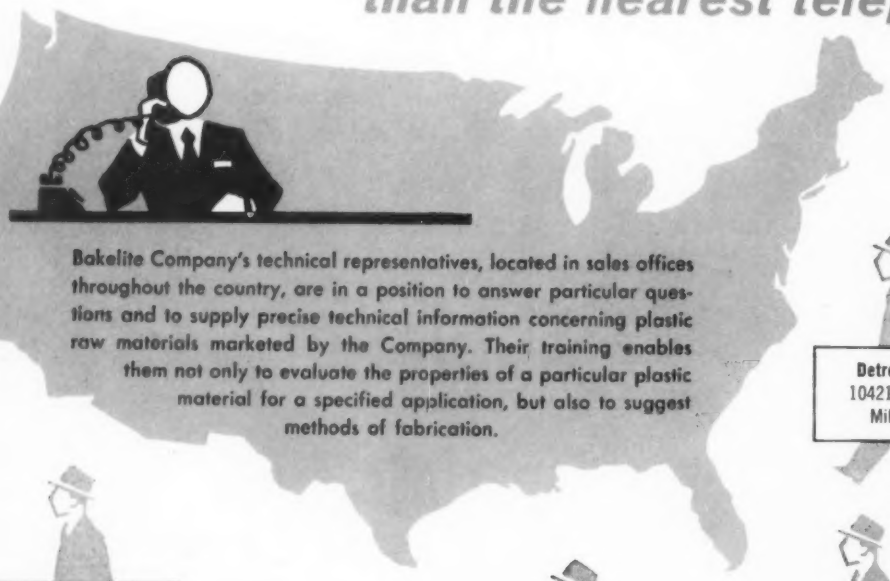


extrusion

LIGHT WEIGHT — Weighing less than water, polyethylene has the lowest specific gravity of any commercial plastic. Greater yield per pound results in reduced costs for manufacturers of polyethylene products.

NO FARTHER FROM YOUR CONFERENCE TABLE

than the nearest telephone . . .



Bakelite Company's technical representatives, located in sales offices throughout the country, are in a position to answer particular questions and to supply precise technical information concerning plastic raw materials marketed by the Company. Their training enables them not only to evaluate the properties of a particular plastic material for a specified application, but also to suggest methods of fabrication.

Washington, D. C.
777 14th Street, N. W.

Detroit, Mich.
10421 W. Seven Mile Road

Hartford, Conn.
410 Asylum Street

Atlanta, Ga.
57 Forsyth Street

Clifton, New Jersey
1051 Bloomfield Ave.

Cincinnati, Ohio
2330 Victory Parkway

Kansas City, Mo.
910 Baltimore Ave.

Boston, Mass.
300 First Avenue
Needham Heights

Cleveland, Ohio
1300 Lakeside Ave., N.E.

Chicago, Ill.
230 No. Michigan Ave.

Larchmont, N. Y.
1877 Palmer Avenue

New York, N. Y.
30 East 42nd Street

Los Angeles, California
2770 Leonis Blvd.

Philadelphia, Pa.
117 So. 17th Street

Rochester, N. Y.
130 Main Street, East

Pittsburgh, Pa.
537 Smithfield Street

St. Louis, Mo.
122 No. Kirkwood Rd.

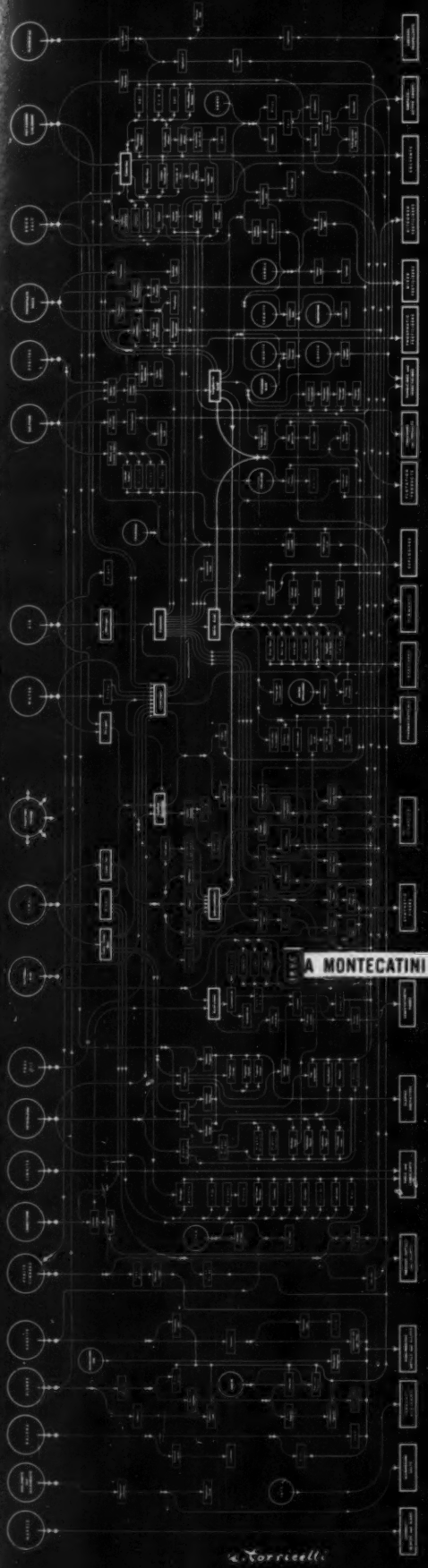
San Francisco, California
22 Battery Street

See Bakelite Company first

because . . .

BAKELITE COMPANY IS FIRST IN PLASTICS

Printed in U.S.A.



PVC
RESIN

vipla

PROMPT DELIVERY FROM STOCK IN U.S.A. AND CANADA

CHEMORE CORPORATION

21 WEST STREET, NEW YORK 6, N. Y. TEL. HA 2-5275







MASTER COLOR: for cleanest, most economical coloring of polyethylene, polystyrene and vinyl—in a wide range of colors—all with excellent dispersion qualities.

AMPACET: polyethylene • polystyrene • cellulose acetate butyrate • vinyl • nylon • Custom Compounding

KROMAPLAST: for brilliant, true colors with excellent dispersion, bleed-fast and fade proof qualities. Also special effects.

AMERICAN MOLDING POWDER AND CHEMICAL CORPORATION

703 BEDFORD AVENUE, BROOKLYN 6, NEW YORK

WRITE FOR SPECIFICATIONS AND DETAILS AND FOR PRICE LIST
PHONE: MAIN 5-7450 • CABLE: **CHEMPROD BROOKLYN** • **CHICAGO OFFICE:** 5850 NO. CLARK ST., CHICAGO, ILL. • TEL.: LONG BEACH 1-4220

"first in epoxies" CIBA

CIBA

ARALDITE® Epoxy RESINS

CIBA COMPANY INC. PLASTICS DIVISION KIMBERTON, PA.

To . . . . . Advance product development

Improve present products

Simplify manufacturing methods

Cut overall costs

CIBA

"first in epoxies"

FOR . . . TOOLING

ELECTRICAL EMBEDMENTS

Typical properties of ARALDITE® Epoxy Resins

	property	test method	typical applications	ARALDITE 502 body solders adhesives coatings electrical laminates tooling	ARALDITE 6005 body solders adhesives electrical laminates tooling	ARALDITE 6010 body solders adhesives electrical laminates tooling	ARALDITE 6020 body solders adhesives electrical laminates tooling
physical	tensile strength (psi)	ASTM D 638-49 T		8,500	8,500	8,500	8,500
	compressive strength (psi)	ASTM D 695-49 T		17,000	23,500	23,000	22,000
	flexural strength (psi)	ASTM D 790-49 T		14,500	16,000	17,000	16,000
	impact strength (Izod, ft lbs/in notch)	ASTM D 256-47 T		0.39	0.36	0.35	0.46
	modulus of elasticity in tension (psi) x 10^6	ASTM D 638-49 T		0.45	0.54	0.54	0.48
	thermal conductivity (cal/sec/cm²/°C/cm) x 10^{-4}	Cencofitch Lab.		4.0	4.8	4.8	4.0
	thermal coef of expansion (linear, °C) x 10^{-5}	ASTM D 696-44		9.0			
	thermal shock	MIL I 16923B		Type B			
	Rockwell hardness	ASTM D 635-44		M82	M104	M105	M100
	shrinkage during cure (linear)			< 2%	< 2%	< 2%	< 1%
	water absorption (24 hrs, %)	ASTM D 570-42		0.12	0.12	0.12	0.05
	moisture vapor transmission (at 100°F/95% RH) (gms/ft²/24 hrs)	ASTM D 697-42 T		< 0.01	< 0.01	< 0.01	< 0.01
	heat distortion point (at 264 psi, °C)	ASTM D 648-45 T		65	74	72	80
	resistance to weathering			excellent	excellent	excellent	excellent
	specific gravity			1.15	1.16	1.16	1.16
	color (Gardner)			7	4	4	7
	melting point (Durran) °C			liquid	liquid	liquid	liquid
	viscosity (at 23°C)	Brookfield (cps) Gardner-Holdt*		4,500	13,000	18,000	30,000
electrical	dielectric strength, short time (volts/mil)	ASTM D 149-44		500	447		415
	surface resistivity (ohms) x 10^{12}	ASTM D 257-49 T		> 5.7			> 5.7
	volume resistivity (ohms - cm) x 10^{13}	ASTM D 257-49 T		> 8.0			> 8.0
	dielectric constant (26.7°C, 60 cps)	ASTM D 150-47 T		4.11	3.73	3.75	3.64
	power factor (26.7°C, 60 cps)	ASTM D 150-47 T		0.002	0.002	0.002	0.007
	curing conditions			24 hrs @ 40°C	24 hrs @ 40°C	24 hrs @ 40°C	7 hrs @ 160°C
chemical	Epoxy content						
	1. Epoxy equivalent/100g resin			0.38	0.52	0.51	0.48
	2. Grams resin containing gm-mol Epoxide			263	192	196	208
	esterification value						0.96

*Resin solution containing 40% Butyl Carbitol

● *In U. S. and Canada CIBA produces basic resins only, to be formulated for intermediate and end uses.*

STRUCTURAL LAMINATES • HI-STRENGTH ADHESIVES
PLASTIC BODY SOLDERS • SURFACE COATINGS

	ARALDITE 6030	ARALDITE 6040	ARALDITE 6060	ARALDITE 6071	ARALDITE 6075	ARALDITE 6084	ARALDITE 6097	ARALDITE 6099
	adhesives coatings vinyl stabilizers	adhesives coatings vinyl stabilizers	adhesives electrical laminates	adhesives air dry coatings laminates	adhesives air dry baked finishes laminates	automotive primers Ester finishes	automotive primers baked and Ester finishes	
			12,000					
			15,500					
			18,500					
			0.70					
			0.45					
			4.0					
			4.8					
			Type B					
			M100					
			0.6%					
			0.08					
			< 0.01					
			109					
			excellent					
	1.16	1.16	1.19	1.21	1.19	1.15	1.15	1.19
	7	7	7*	4*	4*	4*	5*	5*
	liquid	31	67	70	83	100	130	150
	60,000	100,000	D	E	K	S	Z	Z_3
			410					
			> 5.7					
			> 8.0					
			3.89					
			0.0012					
			4 hrs @ 160°C					
	0.44	0.37	0.24	0.205	0.14	0.105	0.046	0.031
	227	270	417	485	715	950	2200	3200
	0.94	0.84	0.70	0.77	0.54	0.57	0.53	0.50

● *See pages 491-492 for data on new CIBA Cromophtal Pigments for plastics.*

CIBA

Plastics Division

Kimberton, Pennsylvania

CIBA "first in epoxies"

CIBA production facilities,
Kimberton, Pennsylvania





The Technical Services of CIBA's Plastics Division are the finest in the field and an important help to users of Araldite Epoxy Resins in formulations of all types. A library of individual Araldite Technical Data Bulletins, with the most up-to-date information, is available to all who seek to utilize the range of properties uniquely combined in this one class of basic resins.

Araldite Sales and Service Offices are located from coast-to-coast



Harry A. Baumstark & Co.
St. Louis, Mo.
Charles L. Burks Co.
Black Mountain, N. C.
John D. Butts
Pittsburgh, Pa.
Commercial Chemicals, Inc.
Buffalo, N. Y.
Dorsett & Jackson, Inc.
Los Angeles, Calif.
Henry L. Grund, Inc.
Cleveland, Ohio
The Houston Co.
Seattle, Wash.
Fred A. Jensen & Associates
Chicago, Ill.
T. C. Kiesel
Cincinnati, Ohio
The A. B. Kohl Sales Co.
Baltimore, Md.
D. H. Litter Co., Inc.
New York, N. Y. & Allston, Mass.
William C. Loughlin & Co.
San Francisco, Calif.
Matteson-Van Wey, Inc.
Detroit, Mich.
Geo. A. Rowley & Co., Inc.
Philadelphia, Pa.
Thompson-Hayward Chemical Co.
Kansas City, Mo. and branch offices

CIBA COMPANY INC. Plastics Division • Kimberton, Pa.





PROFITS UP! **COSTS DOWN!**

when you use

MUEHLSTEIN *reprocessed plastics*

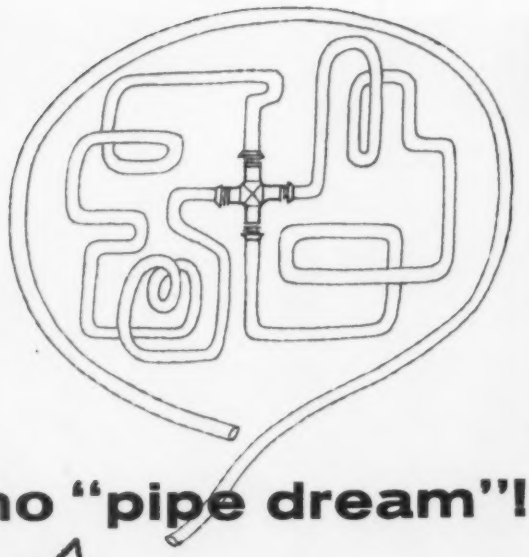
Big material savings plus top quality and efficient color matches add up to increased profits. And that's what you get when you use Muehlstein reprocessed plastics. You're assured of satisfaction when Muehlstein technicians go to work on your special plastics problem. Call on Muehlstein and watch your profits go up.

Muehlstein offers top prices for distressed inventories of molded parts, purgings, and all thermoplastic materials.

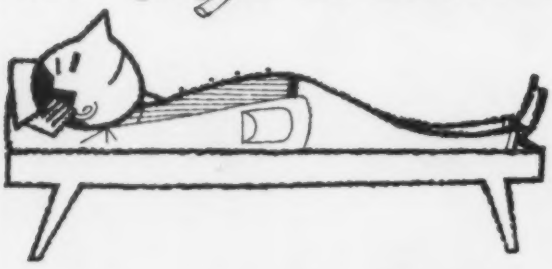
H. MUEHLSTEIN & CO.

60 EAST 42nd STREET, NEW YORK 17, N. Y.

REGIONAL OFFICES: Akron • Chicago • Boston • Los Angeles • Toronto • London
PLANTS AND WAREHOUSES: Akron • Chicago • Boston • Los Angeles • Jersey City • Indianapolis



no "pipe dream"!



No **"maybes"** about it! Whether it's polyethylene pipe or packaging or pails you're producing or planning, chances are Interplastics can save you money with carefully processed polyethylene, natural or colored. Sometimes we have attractive spot lots of virgin polyethylene, too.

But that's not all—Interplastics also deals in polystyrene, nylon, acrylics, vinyl and cellulosics. And —if you have scrap or surplus materials for disposal, we would like to buy it.

Exporters and foreign customers can depend on Interplastics' experienced export and import department. Ask for our handy materials reference index.

INTERPLASTICS CORPORATION

GERALD F. BAMBERGER, president

120 East 56th St., New York 22, N. Y., U. S. A.
Tel: PLaza 1-4280 Cable Address: INPLAKO

Chicago Office: Justin Zenner
823 West Waveland Ave. Tel: GRaceland 2-7373

OUR ONLY FUNCTION IS TO SAVE YOU MONEY

Don't sell that scrap!

Those piles of thermoplastic scrap can easily be converted into high quality materials by our reprocessing methods. Just ship them to ERIE PLASTICS. We're set up to handle every step in every reclaiming operation. We will clean and pelletize your scrap and return it to you as good as new. And we can change the color of scrap, too.

We reclaim

- **polystyrene**
- **acetate**
- **butyrate**
- **polyethylene**
- **nylon**
- **vinyl**

Next time you have scrap of any of these thermoplastics, get in touch with ERIE and find out how inexpensive it will be to convert this overage into re-usable material.

Erie Plastics Company, Inc.

1115-1131 Walnut St. Erie, Penna.

ASK ABOUT

MICCROSOL

for Specialized

Plastisol Finishes

and Coatings



MICHIGAN CHROME
and Chemical Company

8615 GRINNELL AVENUE
DETROIT 13, MICHIGAN

trademark of quality for

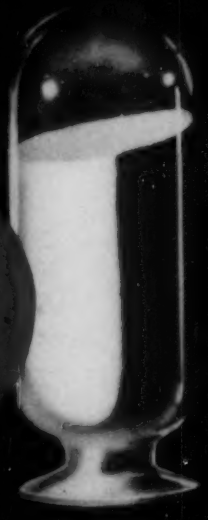
polyvinyl materials

A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY

Geon

Polyvinyl Materials

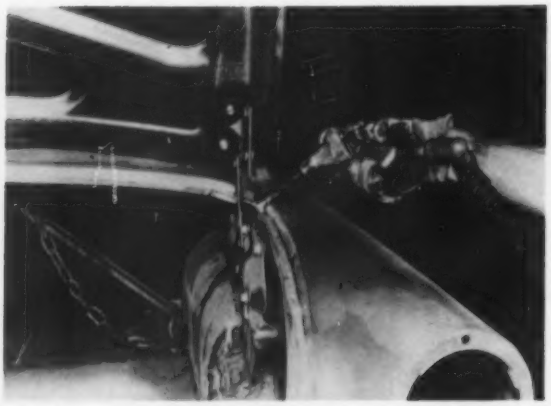
A DIVISION OF THE B. F. GOODRICH COMPANY



B.F.Goodrich Chemical Company

B.F.Goodrich

New Horizons for better products with Geon po



Weather sealant for automobiles



Accordion fold doors



Plastic collar for coffee hotties



Filter chamber for blood administration set



Rigid vinyl plastic pipe



Geon-coated fabric cover

polyvinyl materials

● In little more than a decade, polyvinyl materials —of which Geon is recognized as a standard of excellence—have zoomed to high prominence in plastics. It is estimated that vinyls will become the first plastic to reach a billion-pound-a-year production figure.

ADVANTAGES

The popularity of Geon materials results from an excellent combination of properties—inertness or resistance to attack, superior electrical properties, adaptability of physical properties to meet a wide range of requirements. With proper selection of compounding ingredients, vinyl products can be made which resist most acids, alkalis, alcohols, oils and solvents—and possess exceptional abrasion and weather resistance.

VERSATILITY

End products made from Geon resins or plastics range from flexible upholstery to rigid pipe. Geon may be expanded into foam products like cushioning. Or Geon in liquid form can be applied as a coating to other materials such as paper or fabrics. End products can be made transparent, opaque or translucent in brilliant or subdued colors.

PROCESSING

Processors find Geon a highly uniform, and highly versatile material with which to work. It can be extruded, injection or compression molded, cast, expanded, calendered, used for coatings . . . depending on requirements of the application.

SERVICE

B. F. Goodrich Chemical Company's experience with Geon dates from 1939, when scientists in our laboratories first learned how to make polyvinyl chloride into a useful, workable plastic. Thus our organization, and Technical Development Laboratory, is uniquely equipped to help you apply Geon raw materials for new and better products.

the four basic forms of Geon materials

resins



are free-flowing white powders generally requiring compounding with other ingredients to produce plastics.

plastics



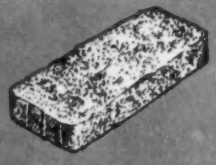
are resins compounded at our plants ready for extrusion or molding. A large number of compounds in cubical form are available in a wide range of colors especially formulated and tested for specific uses.

latices



are water dispersions of polyvinyl chloride polymers supplied as stable, milk-white liquids of approximately 50% total solids. They form clear, tough films or coatings and can be compounded to give opaque or colored deposits.

polyblends



are resins plasticized with Hycar nitrile rubber, supplied in sheets similar in appearance to crude rubber. Nitrile rubber plasticizer provides the advantage of non-extractability for such applications as food packaging and cable jacketing.



Wall Covering made of Rigid Geon provides realistic effect of brick or stone, is waterproof, washable, resists oil and grease.



Wall Covering with Geon Coating has a fabric base material. It is produced in a range of colors from pastels to deep tones, is attractive and durable.

Geon
Polyvinyl Materials

Calendering & Coating

Products range from flexible upholstery to rigid panels; decorative to functional coatings



Rigid Vinyl Windows are installed easily—simply nailed in place. They resist corrosive atmospheres as well as weather.



Convertible tops coated with Geon are available in a wide range of fade-resistant colors. With the fabric protected, tops last longer in weather.



Geon-Coated Nylon proves a superior material for these two applications: swimming pool and tarpaulins. This construction is light yet strong, waterproof, resistant to wear and tear.

● Calendered film materials made from Geon are familiar as shower curtains, bedspreads, bowl covers, raincoats, protective covers, and many others. Heavier sheeting is used for upholstery, tarpaulins, luggage. Geon may be supported by a backing material for added strength.

Geon latex is an ideal lightweight coating. Paper may be coated for decorative reasons, as in wallpaper or shelfpaper, or for functional reasons, as in food packaging papers. Coatings may be applied to fibers to provide exceptional resistance to oil, chemicals, and water.

Coating Materials include Geon latices, preferred where thin pin-hole free coatings are desired without requiring use of volatile solvents; Geon resins for plastisols and organosols, preferred for medium and heavy coatings; solvent solution systems, most useful for thin coatings, particularly where very high gloss or transparency are desired.

Another application is the use of Geon for pigment and fiber binding and paper saturation. For example, Geon latices make a continuous sheet of random or oriented fibers in making non-woven fabric.



Vinyl coating on Steel provides a tough, handsome finish for business machines. The same coating on metal drums or tanks can provide resistance to chemical attack.

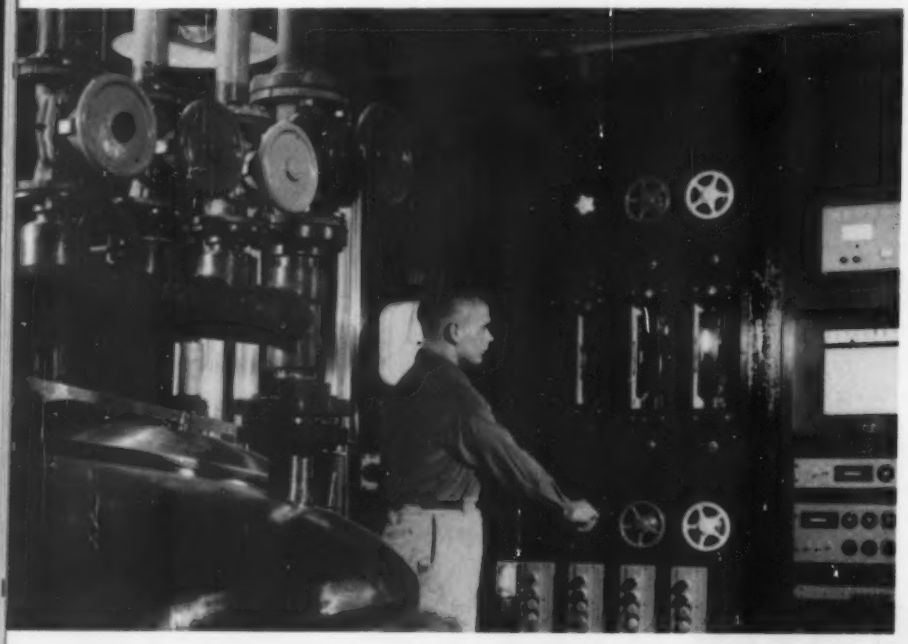
B.F.Goodrich Chemical Company

Extrusions

From superior electrical insulation to gasketing; flexible belting to rigid pipe and ducts

● Geon polyvinyl materials offer outstanding ease of processing by extrusion. The product range is extremely wide. Some examples are thin and heavy walled tubing and hose, belting, trim for luggage and upholstery, gasketing, electrical tape, rigid corrosion-resistant piping and ductwork.

Geon is also extruded as a covering on other materials—as a weather resistant coat on clothes lines, as sturdy insulation on wire and cable, and lightweight cable jacketing.





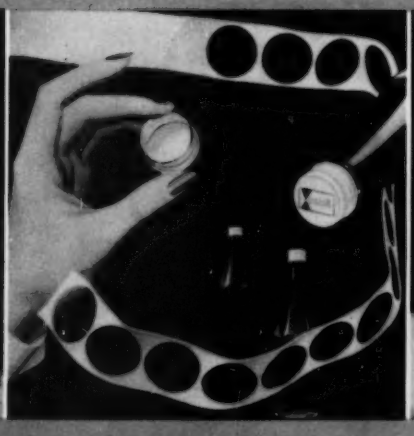
Rigid Vinyl is a fast-growing material for piping that must withstand chemical attack. It is also immune to galvanic corrosion, eliminating the major source of failure in underground lines. Vinyl pipe is light weight, easy to install.



Plastic Springs—special jacketing compound extruded on telephone conductors provides unique flexing action.



Weather Stripping molds itself perfectly to irregularities or gaps in windows or doors, withstands rough weather.

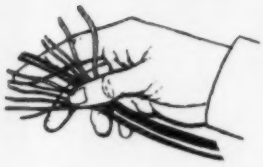


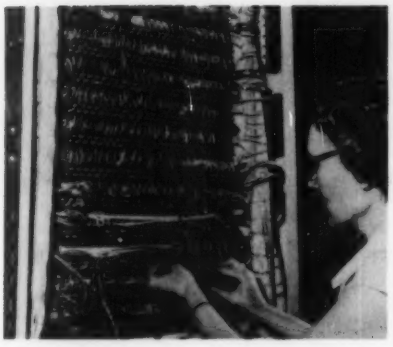
Bottle Cap Liner is white, clean-looking, exceptionally smooth. Eliminates sticky caps, provides excellent seal.



Drain Rail keeps water out of convertibles. Geon is ideal here because it won't crack, chip or peel.

INSULATION





Electrical panel in aircraft uses color-coded wiring with insulation of Geon.



Building wire insulated with Geon materials has exceptional aging characteristics, maintains insulation strength and flexibility.

● Geon vinyl compounds and resins for primary insulation and jacketing have extended their usefulness many times since their introduction twenty years ago. Applications include building wire, communications and electronics wiring, automotive secondary wiring and electrical equipment.

This insulation offers outstanding advantages: excellent dielectric properties combined with good resistance to abrasion, weathering, and heat; nonflammability, low temperature flexibility, and extreme inertness to oil, chemicals, and solvents. In addition, Geon vinyl retains its properties over many years of severe use, indoors or out.

Geon electrical-grade materials are supplied either as finely powdered resins, or as completely compounded plastic cubes of uniform size. The resin permits the processor to select modifying ingredients and compound to his own specifications. Geon plastic compounds are generally used as supplied and are available in different formulations designed to meet many government and underwriters standards.

B.F.Goodrich Chemical Company

Molding

For rigid phonograph records and soft dolls, and a new star—vinyl foam





Rotational Casting of toys is handled by this automatic machinery. Molds which are carried on chain pass through the oven to fuse the Geon plastisol.



Rigid vinyl moldings include automobile dashboard, piping tee, motor housing.

● The versatility of Geon polyvinyl materials is shown by the many types of products which can be made by molding processes. High fidelity phonograph records are compression molded, pipe fittings injection molded. Slush- or low-pressure molding of Geon plastisols is used for dolls, toys, fish lures and gaskets.

Foam products made of Geon are proving superior in cushioning material, floats, shock-absorbing padding in automobiles, thermal insulation, etc. Either open or closed cell vinyl can be produced from Geon paste resin.



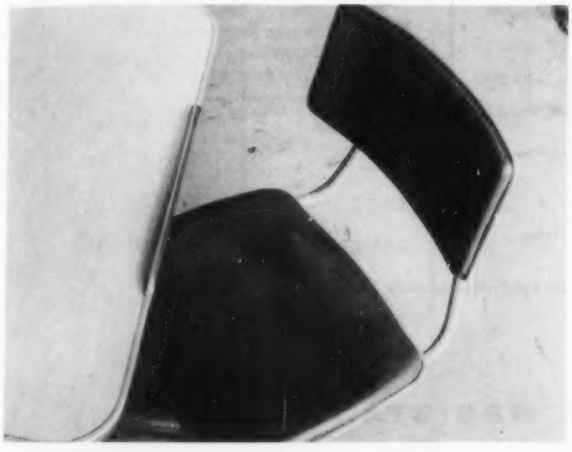
Modern Packaging of Geon helps sell the merchandise. Other packaging uses for Geon include protective paper coatings, film, sealants, tape, barriers.



Drain Rail for carrying water from freezing unit is one of the largest injection molded vinyl parts ever made. Easy to clean, stays flexible, odor-free.



High Fidelity Records are pressed from Geon resin. Uniformity, wear resistance, and dimensional stability are highly important.



School Can Be Fun. Cushioning material of Geon foam makes comfortable seating that keeps its spring and resiliency.

Foam and Sponge

• Expanded vinyls have opened many new-product markets. The closed cell vinyl structure is referred to as "sponge", the open cell structure as "foam". Foam (or sponge) is excellent for insulation, shock absorbing, and cushioning applications. In addition sponge is used for buoyancy.

To make vinyl sponge, a chemical blowing agent is incorporated into a plastisol and fusing is done under high pressure in a mold. The blowing agent decomposes under the heat to liberate a gas (usually nitrogen) which expands the vinyl.

Foam is made by dissolving an inert gas in a plastisol under relatively high pressure and releasing it through a spray nozzle into a mold or onto a casting surface. Fusion is then done by dielectric heat. By the use of this patented method, continuous production of vinyl foam is commercially successful.



It Floats. Swimming boards, fishing floats, boat bumpers all capitalize on buoyancy of Geon sponge.



Thirsty Mop has sponge-like strings made of Geon plastisol. The strings absorb more water, shed no lint.

B.F.Goodrich Chemical Company



TYPICAL PHYSICAL PROPERTIES

	Flexible Geon	Rigid Geon
Specific gravity	1.20-1.55	1.32-1.40
Ultimate Tensile Strength (psi, max.)	3,500	8,000
Ultimate Tensile Strength (psi, ave.)	1,500-3,500	5,500-7,000
Ultimate Elongation (%)	200-450	5-25
Hardness (Shore Durometer A)	50-100	70D-85D
Maximum Service Temperature (°F)	170-220*	150
Minimum Flexibility Temperature (°F)	0 to -70	—
Abrasion Resistance	excellent	excellent
Age Resistance	excellent	excellent
Sunlight Resistance	excellent	excellent
Electrical Properties Volume Resistivity (ohm-cm at 25 °C) (maximum)	$1\text{-}10 \times 10^{12}$ to $4\text{-}7 \times 10^{14}$	$1\text{-}5 \times 10^{14}$ to $1\text{-}5 \times 10^{16}$
Dielectric Constant at 60 cycles at 25 °C	5.5-9.1	2.3-3.7
Power factor at 60 cycles at 25 °C	0.05-0.15	0.02-0.03

*Underwriter Lab approval granted for electrical compound to be used continuously at 105 °C (220 °F)

TYPICAL CHEMICAL RESISTANCE DATA

Type of immersant	*Geon*
Acidic Salts	excellent resistance
Alcohols	resists action of aliphatic alcohols
Aldehydes	resists action of formaldehyde
Alkaline solutions	excellent resistance
Esters	not recommended because esters are softeners for polyvinyl chloride
Halogenated Hydrocarbons	not recommended
Inorganic Acids	resists most acids at all concentrations under a wide variety of conditions
Edible Oils	excellent resistance
Ketones	not recommended
Neutral Salts (Saturated Solution)	excellent resistance
Organic Acids	resists action of most acids, except glacial acetic.
Phenols	not recommended
Sulfur Derivatives	resists most aliphatic sulfur compounds except carbon bisulfide.
Vegetable Oils	excellent resistance
Water	excellent resistance

GUIDE TO GEON POLYVINYL MATERIALS

GEON MATERIALS	PROCESSING METHODS	FINISHED PRODUCTS
Polyvinyl Chloride Resins 101—General Purpose 101EP—Ideal for powder mixing 103EP—Lower temperature processing and rigids. 118—Easy processing calendering resin 202—General Purpose Copolymer	Calendering Press polishing Embossing Printing Spanishing Extrusion Injection molding Compression molding	Calendered Supported and unsupported sheeting for upholstery, luggage, wall covering, automobile interiors Films for shower curtains, rainwear, tablecloths, draperies Floor and wall tiles Extruded Wire and cable insulation Garden hose Tubing for beverage, industrial and pharmaceutical applications General extruded sections such as belting, welting, tapes, chair webbing and laces Injection molded Grommets, gaskets, electrical plugs, toys, automotive parts
Geon Polyblend 503 H A 45-55 colloidal blend of Hycar American rubber and Geon polyvinyl chloride in which the Hycar serves as a non-migrating plasticizer for the vinyl resin replacing the usual ester type plasticizers. Offers certain advantages of cementability and smoother extrusion.		
Geon Plastic Compounds A series of many different compounds in a full color range. For use primarily in wire and cable insulation, general extrusion, and injection molding. Supplied as cubical granules.		
Geon Resins *For Rigid Applications* 103 EP, 428, 404 HI, 421 — Special vinyl chloride polymers		Calendered Sheets for finishing by press polishing or laminating Extruded Wire and cable insulation Chemical piping, rod, sheets Compression molded Press polished and embossed sheets Phonograph records Injection molded Belt buckles Electrical parts Pipe fittings Phonograph records Deep drawn Chemical containers, fume ducts, hoods, etc.
Geon Solution Resins 222, 427, 421. Special vinyl chloride polymers designed for solution applications. Inexpensive solvents such as toluene and xylene are excellent for Geon 222.	Solution coating Roll coating Knife blade Air knife Dip Film coating Spray coating	Coated paper and fabrics Cast films Protective coatings on metals
Geon Paste Resins 121, 122 Vinyl chloride polymers of controlled particle size. Can be dispersed either in a resin-plasticizer-diluent system (organosol) or resin-plasticizer system (plastisol) to make a paste of spread or dip coating consistency.	Coating Knife Reverse roll Dip Spray Low pressure molding Casting	Spread coated Luggage and upholstery cloth, window shades, decorative paper Dip coated Gloves, wire dish drainers, electroplating racks, footwear Spray coated Wood articles, sheet metal Cast Film, toys, dolls, prosthetic devices Sponge and foam
Geon Latices 151, 450X167, 351, 352, 552, 576, 450X5, 652.	Coating	Coatings and binders for decorative paper, hot drink cups, food cartons, fiber, fabric, felt, leather

B.F.Goodrich Chemical Company

Other outstanding raw materials by B.F.Goodrich Chemical Company

Hycar

Hycar man-made dry rubbers are uncompounded polymers that include the oil resistant nitrile types, a polyacrylic for high temperature use, and a brominated butyl with exceptional characteristics of compatibility and cure. Compounding with vulcanizing agents, loading pigments and softeners is easily accomplished on conventional rubber equipment. Hycar rubbers are also supplied as water dispersions or latices that reflect the properties of their dry rubber component. Generally, Hycar materials are resistant to oil, solvents, and abrasion, have low compression set, and good aging qualities.

Good-rite CHEMICALS

Good-rite chemicals include antioxidants, hydrophilic polymers, biochemicals, and chemical intermediates. They have an outstanding reputation for purity and dependability. Experimental samples and further information are available on request.

Harmon COLORS

Harmon colors are organic pigments which offer a complete range of colorants for automotive and other industrial enamels and lacquers, and for rubber, plastic, printing ink, paper, and textiles.

Call for information and technical assistance

This booklet has described the wide range of Geon polyvinyl materials that are available and has touched upon some of their many applications. For specific technical information on their uses and how they can be successfully applied to your product or operation, send enclosed postcard or contact the nearest B. F. Goodrich Chemical Company Sales Office. We'll gladly help you select and apply the Geon material best suited to your needs.

HEADQUARTERS OFFICE:
3135 Euclid Avenue, Cleveland 15, Ohio; UTah 1-8200

SALES OFFICES:

2116 Prudential Bldg.
Prudential Plaza
Chicago 1, Illinois
SUperior 7-3214

1607 USMC Bldg.
140 Federal Street
Boston 10, Massachusetts
HAncock 6-1668

409 Bank of Georgia Bldg.
1430 W. Peachtree Street
Atlanta 9, Georgia
TRinity 5-5642

1112-19th Street, N.W.
Washington 6, D. C.
REpublic 7-3414

301 Petroleum Bldg.
714 West Olympic Blvd.
Los Angeles 15, California
RIchmond 9-9157

19th Floor
415 Madison Avenue
New York 17, N. Y.
TEmpleton 8-8600

International Sales Department
3135 Euclid Avenue
Cleveland 15, Ohio
UTah 1-8200
Cable Address: GOODCHEMCO

251 King Street West
Kitchener, Ontario
Canada
SHerwood 5-7351

B.F.Goodrich Chemical Company

B.F.Goodrich — *A Division of* The B.F.Goodrich Company

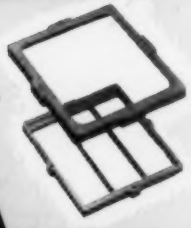
Litho in U.S.A. June 1957

the PREFERRED material for 1,001 end-use products...

Cycolac is a lightweight, uniform resin, specially suited for the manufacture of any product which requires high-impact strength, light weight, non-corrosion and chemical resistance. Cycolac parts can be machined, much like other thermoplastics; threaded, sawed, milled, drilled, buffed, blanked, punched or sheared. It can be lacquered, enameled or printed and is easily bonded or cemented to itself.

lightweight...
Lightest of all rigid thermoplastics. Sp. Gr. 1.01.





chemical resistance...
Especially resistant to battery acids; equally effective against many oils, solvents and other corrosive chemicals.

good electrical properties...
Exemplified in electrical device which enables linemen to open switches on heavy power lines.





high impact strength...
Tested and proved to endure extremely rough usage and severe punishment.

CYCOLAC®

HIGH-IMPACT THERMOPLASTIC RESIN

...FOR MOLDING · EXTRUDING · CALENDERING

Some of the 1,001 End Use Products readily made with CYCLOLAC

• Extruded Pipe & Molded Fittings • Corrosion-proof Valve Bodies • Signs — Display Racks • Desk Tops • Dispensers • Tote Boxes • Toys • Appliances, Housings and Parts • Kitchen Accessories • Safety Equipment • Tool Handles

Write for technical literature and illustrated brochure

MARBON CHEMICAL
Division of Borg-Warner
GARY, INDIANA

ENGINEERING B-W PRODUCTION

Marbon

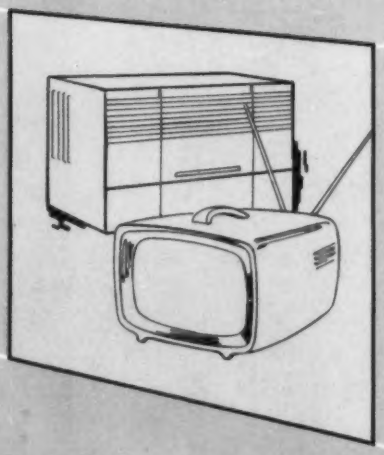

IRENE KAPI
OMNI EVERYWHERE...
Materials,
Machinery, Methods
for the Plastics Industry
OMNI (London) LTD.
35 Dover Street • London W. 1
OMNI Products Corporation
460 Fourth Avenue • New York 16, N. Y.
Affiliated Companies in: Argentina • Austria • Brazil • Canada • Chile • France • Germany • Japan • Mexico • Venezuela

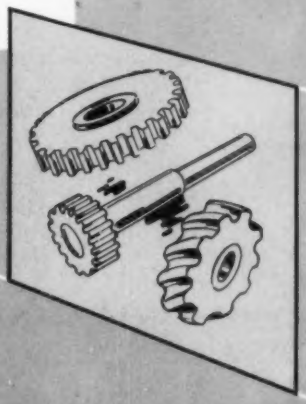
FIBERFIL

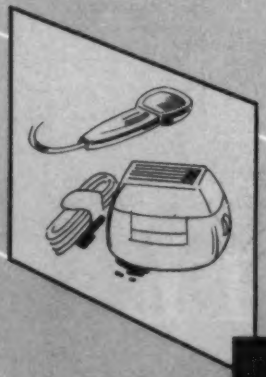
lifts the limits on markets for injection molders!

Since the introduction of FIBERFIL — just a few short years ago — applications of these glass-reinforced injection molding compounds have multiplied nationwide. Logically so, too, because FIBERFIL's unique physical properties removed limitations imposed by non-reinforced plastics to open up a boundless field of business for injection molders. Here for the first time were higher compressive strength and heat resistance, better control over mold shrinkage and warpage . . . qualities that make both FIBERFIL Styrene G and FIBERFIL Nylon G unexcelled for applications demanding exceptional accuracy plus outstanding impact strength and durability. Here, in fact, was (and is) the master key to brand-new profits for molders and better products for manufacturers.

More and more millions of pounds of FIBERFIL molding compounds are being produced to meet ever-mounting demand. Study the outstanding properties detailed on pages that follow — and you will see why.







Reinforced Insurance

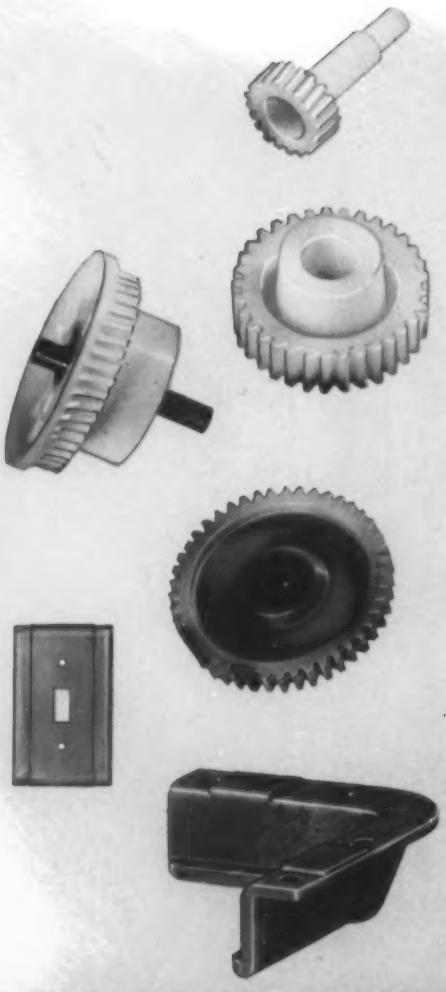
FOR ALL INJECTION MOLDING!

FIBERFIL

FIBERFIL, INC.

FOX FARM ROAD • WARSAW, INDIANA

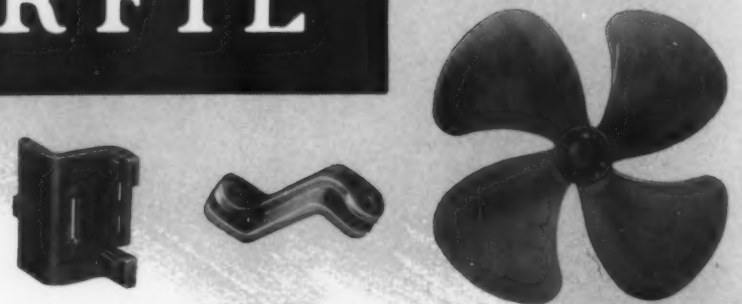
TYPICAL APPLICATIONS



MADE POSSIBLE BY FIBERFIL'S *Reinforced Insurance*

- Air Conditioning — Components
- Appliances — Components
- Boat Fixtures
- Bowling Bag Bottoms
- Business Machines — and Keys
- Cabinet Doors and Storage Drawers
- Cameras — (Shells)
- Cases of All Kinds
- Casters
- Chemical Containers
- Clock Cases
- Coil Forms
- Cutlery Handles
- Dictating Machines — Components
- Electric Shavers — Cases
- Fan Components
- Filing Baskets
- Fishing Buoys
- Freezers — Components
- Game Boards
- Gaskets
- Gears
- Golf Bag Bottoms
- Hi-Fidelity — Components
- Helmets — Football, Safety, Etc.
- Meter Housings — Electric, Gas, Etc.
- Microphone Housings
- Packaging
- Pulleys
- Reels — Film, Tape, Etc.
- Reflectors — Outdoor
- Rifles — Stocks and Components
- Rollers
- Stair Treads
- Stool Seats and Fittings
- Surgical Equipment
- Switch Plates
- Terminal Blocks
- Textile Parts
- Tote Boxes
- Toys
- Tractor Seats
- Vacuum Cleaners — Components
- Zippers

FIBERFIL

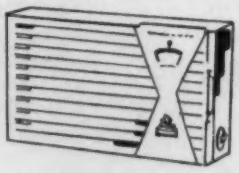


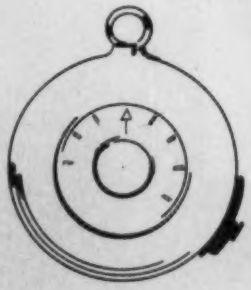
PROPERTIES OF FIBERFIL REINFORCED INJECTION MOLDING COMPOUNDS

Data shown for representative grades — others available.

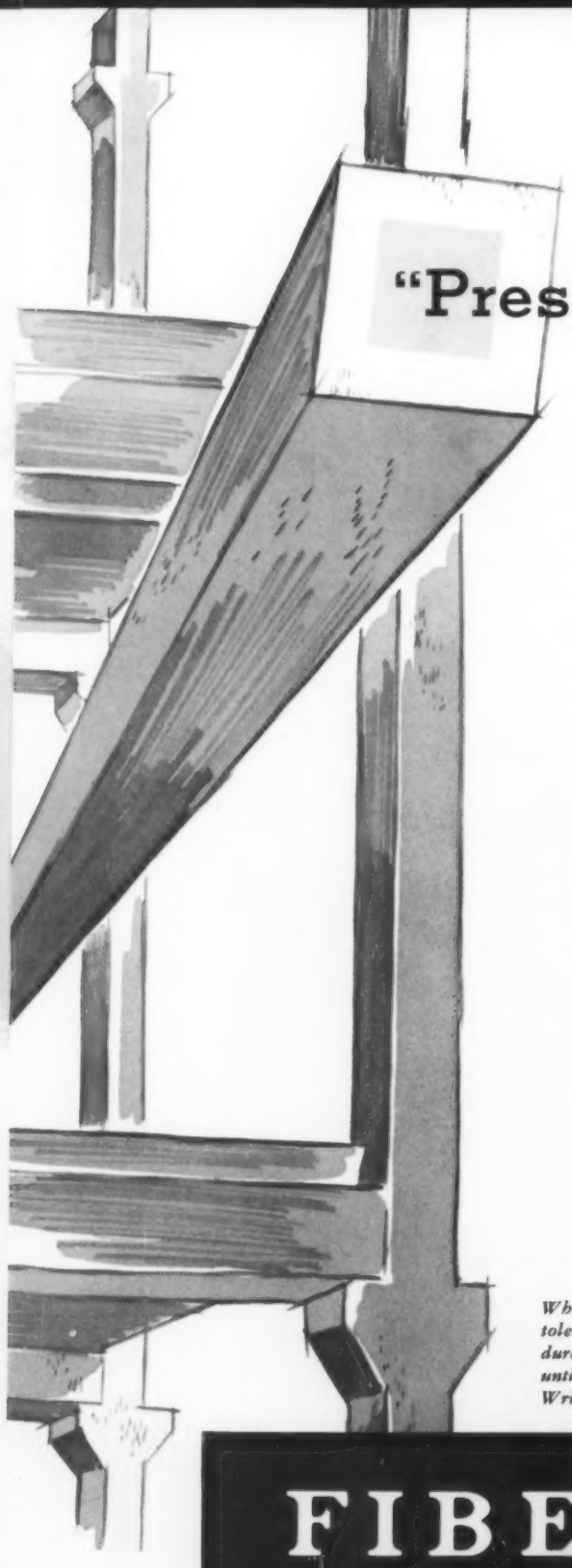
	FIBERFIL STYRENE "G" (GLASS)	FIBERFIL NYLON "G" (GLASS)
PHYSICAL		
Molding qualities	Good	Excellent
Compression molding temp., °F.	275 – 350	
Compression molding pressure, p.s.i.	2000 – 5000	
Injection molding temp., °F.	450 – 575	450 – 600
Injection molding pressure, p.s.i.	15,000 – 20,000	10,000 – 25,000
Compression ratio	2.5 – 2.7	
Mold shrinkage, in. per in.	.001 – .003	.003 – .005
Specific gravity	1.32 – 1.35	1.33
Specific volume, cu. in. per lb.		
Refractive index, nD		
Tensile strength, p.s.i.	10,000 – 14,500	12,000 – 18,500
Elongation, %	.75	7.5
Modulus of elasticity in tension, 10^5 p.s.i.	12.0	11.0
Compressive strength, p.s.i.	23,225	21,900
Flexural strength, p.s.i.	16,000 – 18,000	25,000 +
Impact strength, ft.-lb. per in. of notch (½ x ½ in. notched bar, Izod test)	1.5 – 2.5	2.
Hardness, Rockwell	M80 – M90	M85 – M95
Thermal conductivity, 10^{-4} cal. per sec. per sq. cm. per 1°C. per cm.		
Specific heat, cal. per °C. per gm.		
Thermal expansion, 10^{-5} per °C.	Low	Very low
Resistance to heat, °F. (continuous)[a]		
Heat distortion temp., °F.	218 – 222	350
Volume resistivity, ohm-cm. (50% relative humidity and 23°C.)	6.74×10^{15} and 10^{14} — 2.6×10^{14}	4.88×10^{15} — 5.73×10^{15}
Water absorption, 24 hr., ⅛-in. thickness, %	.07	.3 – 1.2
Burning rate	Slow	Reduced
Machine qualities	Good	Good
Clarity	Translucent to opaque	Translucent to opaque
ELECTRICAL		
Dielectric strength, short-time, ⅛-in. thickness, volts per mil	440 – 496	520 – 487
Dielectric strength, step-by-step, ⅛-in. thickness, volts per mil	399 – 418	395 – 430
Dielectric constant, 60 cycles	3.11 – 3.22	3.99 – 4.03
Dielectric constant, 10^3 cycles	2.97 – 3.06	3.84 – 3.92
Dielectric constant, 10^6 cycles	2.94 – 2.98	3.37 – 3.45
Dissipation (power) factor, 60 cycles	.0364 – .0490	.0155 – .0210
Dissipation (power) factor, 10^3 cycles	.0192 – .0535	.0196 – .0236
Dissipation (power) factor, 10^6 cycles	.0019 – .0025	.0171 – .0176
Arc resistance, sec.	95 – 109	147 – 149
CHEMICAL		
Effect of sunlight	Yellows slightly	Discolors slightly
Effect of weak acids	None	Resistant
Effect of strong acids	Attacked by oxidizing acids	Attacked
Effect of weak alkalies	Resistant	None
Effect of strong alkalies	Fair	Fair
Effect of organic solvents	Soluble in aromatic and chlorinated hydrocarbons	Resistant to common solvents











"Prestressed" Strength...

solid foundation for building ever-greater productivity and ever-better profits by injection processes

THE same basic principle of the prestressed beam, an advancement launching a new era in construction practices, has made *reinforced* FIBERFIL today's most significant contribution to the plastics industry. Because it more than doubles the precision, permanence, and strength of products that can be injection-molded . . . and is proving successful in more and more applications that could not be mastered with ordinary plastics . . . demand for FIBERFIL is already running millions of pounds and growing rapidly.

You, too, can build both present sales and an ever-brighter future — upon the solid foundation of FIBERFIL's *Reinforced Insurance.*

Whatever the product or part, however close the tolerances or however exacting the requirements for durability, don't decide it cannot be injection molded until you investigate FIBERFIL. Write, wire, or phone for further information.

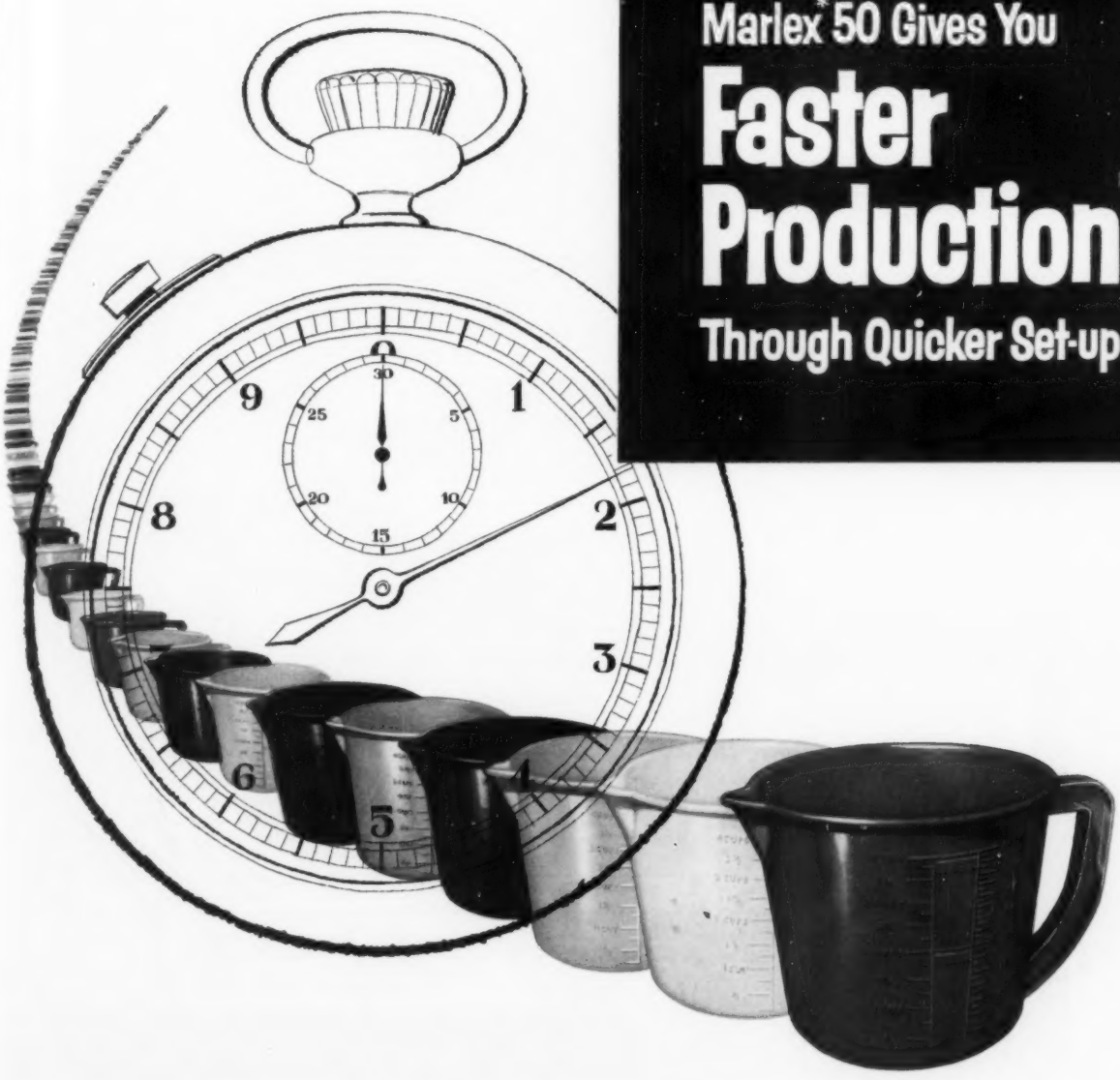
FIBERFIL

Reinforced Insurance

for all injection molding!

FIBERFIL, Inc. • FOX FARM ROAD • WARSAW, INDIANA

Marlex* 50 Gives You Faster Production Through Quicker Set-up



Because MARLEX 50 sets up at higher temperatures than conventional polyethylene, your molding cycle can be speeded up. And the greater strength of MARLEX permits the use of *less resin* to achieve desired rigidity, so you get more items per pound of material. These are important manufacturing economies.

Greater strength, greater ability to withstand heat and cold, superb resistance to penetration by moisture, gases, oils and chemicals . . . all these qualities make possible the manufacture of many new and better products from MARLEX. Write your nearest Phillips Chemical Company office for further details.

*MARLEX is a trademark for Phillips family of olefin polymers.

MARLEX 50 Phillips New, Rigid POLYETHYLENE

PLASTICS SALES DIVISION, PHILLIPS CHEMICAL COMPANY

A Subsidiary of Phillips Petroleum Company, Bartlesville, Oklahoma

DISTRICT OFFICES

NEW ENGLAND	NEW YORK	AKRON	CHICAGO	WESTERN	SOUTHERN & FOREIGN
322 Waterman Avenue, East Providence 14, R. I. GEneva 4-7600	80 Broadway, Suite 2535 New York 5, N. Y. Digby 4-3480	318 Water Street, Akron 8, Ohio FRanklin 6-4126	111 S. York Street, Elmhurst, Ill. TErrace 4-6680	330 Security Bldg., Pasadena, Calif. RYan 1-6997	Adams Building, Bartlesville, Oklahoma Bartlesville 6600

EPON® Resins*

a complete line of epoxy polymers

From SHELL...

SALES SPECIFICATIONS

Epon resin type	562	815	820	828	834	864	1001	1004	1007	1009
Melting Point, °C[1]	liq.	liq.	liq.	liq.	liq.	40-45	65-75	95-105	125-135	145-155
Color (Gardner) max.[2]	5	8	8	8	8	8	4	4	5	5
Viscosity[2] Gardner-Holdt poises	0.9-1.5	5-9	40-100	135-195	O-V 3.5-9	A_3-B 0.30-0.6	D-G 1.0-1.6	Q-U 4.3-6.2	Y-Z_1 17-27	Z_2-Z_5 36-100
Epoxide Equivalent[3]	140-165	175-205	185-205	185-205	225-290	300-375	425-550	875-1025	1900-2450	2400-4000
Epoxide Equivalent[4]	.60-.71	.48-.57	.48-.54	.48-.54	.35-.44	.26-.33	.18-.24	.09-.11	.04-.05	.03-.04

TYPICAL PROPERTIES

Epon resin type	562	815	820	828	834	864	1001	1004	1007	1009
Weight, lb./gal.	10.2	9.5	9.7	9.7	9.7	9.9	9.9	9.6	9.6	9.6
Esterification Value[5]	65	85	85	85	105	115	145	175	200	220

1. Durrans Mercury method.
2. Epon 562, 815, 820, and 828 on undiluted resin; Epon 834 as 70% solution, all other types as 40% solutions, all in butyl carbitol at 25°C.
3. Grams of resin containing one gram-equivalent of epoxide.
4. Grams epoxide equivalent per 100 gms of resin.
5. Grams of resin required for complete reaction with one gram-mole (e.g., 60 g. of acetic acid) of an organic acid.

When you make Shell your source for Epoxy Resins, you can be sure that the products you receive will meet the highest standards set by industry. Prompt delivery . . . in quantities from drums to 30,000-pound batches . . . is assured from conveniently located storage facilities.

• • •

Shell's technically trained personnel are prepared to assist you in making your products better and less costly . . . with Epon resins. Write for full information today.

SALES SPECIFICATIONS—SOLUTIONS			
Epon resin solutions	864-C-75	1001-BT-70	1001-CX-75
Non-Volatile component	Epon 864	Epon 1001	Epon 1001
Volatile composition	MIBK	MEK-Toluene 50:50	MIBK-Xylene 65:35
Solids (±1%)	75%	70%	75%

*(*Epon resins are the epoxy polymers made exclusively by Shell Chemical Corporation)*

SHELL CHEMICAL CORPORATION

CHEMICAL SALES DIVISION, 380 Madison Avenue, New York 17, New York

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis
IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited • Montreal • Toronto • Vancouver

FORMACOLOR*

THE SUPERIOR COLOR CONCENTRATE FOR INJECTION MOLDING



Color-power is sales-power. Those pellets of FORMACOLOR give your finished product the bright color, the RIGHT color, the color with the impact and the stop-look-and-buy appeal.

All the approved pigments required to achieve a rich and uniform finished color are contained in FORMACOLOR. It's made to be diluted at a ratio of **four to one** and costs no more than, a few pennies a pound.

Westchester Plastics, Inc. knows that at the consumer level, the color of the bottle is as important as the product it contains. FORMACOLOR is one of the many color concentrates, for polyethylene and most other thermoplastic materials, prepared by Westchester with this aim in mind . . . to command consumer attention. Advise us of the resin you intend to use and the color you need. We will forward you a sample for evaluation by your staff.



remember! the color makes the SALE!

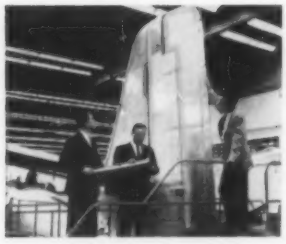
WESTCHESTER PLASTICS, Inc.

326 WAVERLY AVENUE, MAMARONECK, N. Y. • Mamaroneck 9-5980

Custom Compounders of Polyethylene Molding Powder and other Thermoplastic Materials

Manufacturers and Developers of Unicolor and Formacolor

*Pliothene. Formacolor, Unicolor® T.M. Reg. U.S. Pat. Off.



Grumman S2F, new Navy sub destroyer, has wing-tip and tail-fin parts made with HETRON-based material. Glass reinforcing mat is supplied to the fabricator in convenient roll form, pre-impregnated with resin.

If your reinforced plastic product must be strong . . . beautiful . . . fire-

Fire retardance, strength, and excellent molding properties combine in HETRON to give you a versatile material you can often use even where conventional polyester resins would not be applicable.

While fire retardance is frequently desirable in a part, it is by no means the only reason for specifying HETRON. Often HETRON is chosen for its other physical, chemical, and electrical properties, closely matched to the increasingly strict quality requirements for reinforced laminates in today's market.

Excellent physicals

Tests show that you can incorporate desirable physical properties in your product in highest degree with HETRON resins.

Table I, upper right, compares typical physical values for 0.1" laminates made with HETRON and with 10 other leading polyester resins. In this comparison HETRON 92, a rigid resin, surpasses the average of the 10 non-fire-resistant rigid resins in almost every property shown.

Values for two semi-rigid resins, HETRON 32A and HETRON 33, also shown in Table I, compare favorably even with those for the rigid resins. Low water absorption, excellent wet-strength retention, and, for HETRON 32A, an exceptionally high heat distortion point, are features of these resins.

For comparative purposes, Table II, upper right, lists typical properties of slightly heavier ⅛" laminates made with HETRON 92 and HETRON 32A.

Inherently self-extinguishing

HETRON laminates are self-extinguishing. They will burn at the point where a hot flame is applied, but snuff out as soon as the flame source is removed.

Typical daylighting panels made with HETRON, for example, test within a range of 20 to 75 in flame-spread rating, by procedure ASTM E84-50T (Tunnel Test). This compares with ratings of 100 for red oak, and over 400 for conventional unfilled polyester resins.

Flame retardance is chemically locked into the resin, through tight bonding of chlorine atoms in the molecule. This unique, inherent flame retardance is obtained without additives and consequently without loss of desirable mechanical properties.

Chemical resistance

HETRON resins exhibit excellent resistance to chemical attack. Immersion tests in water, dilute hydrochloric acid, 60% sulfuric acid, dilute sodium hydroxide, and kerosene, over a range of temperatures and for time periods ranging up to 60 days, produce little or no weight change in the cast unfilled resins.

Electrical properties

For the electrical designer, HETRON offers very low loss factor over a wide range of frequencies; dielectric constants generally lower than with other polyesters; relatively little change during long exposure to high humidity.

A growing use of HETRON is in glass-reinforced insulation for heavy-duty switchgear, where HETRON's fire retardance, strength, arc resistance, and other electrical properties contribute to improved design, safety, and high operating efficiency.

Molding advantages

You get an exceptionally smooth, well-filled surface when you mold with HETRON. This smoother surface can often reduce fabrication costs; it has cut hand-finishing time on parts by as much as 50%.

HETRON provides a good base for alkyd finishes. Parts can be baked at 350° F for 90 minutes without cracking or crazing.

Military applications

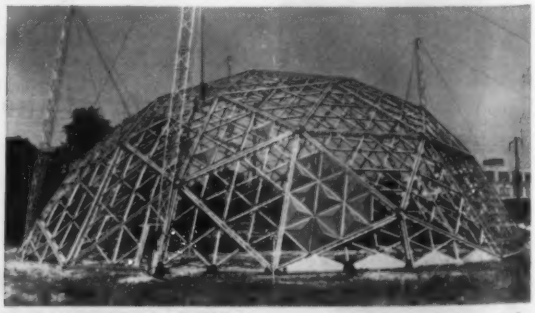
HETRON is being used in military aircraft parts such as wing tips, tail fins, window frames, air ducts, battery trays, radomes, and antenna covers. It is specified for 55-foot radomes used in perimeter defense, and for 40-foot landing craft hulls.

HETRON 92 and semi-rigid HETRON 32A are manufactured to meet Military Specification MIL-R-7575A, Types I, II, and III.

For complete information on HETRON resins, send for technical data sheets listing properties of the liquid resins, cured unfilled resins, and glass-cloth laminates. They include recommendations on handling and curing, and other useful information.



Fire-Retardant Daylighting Panels, made with HETRON by 10 major fabricators, carry U.L. label and Factory Mutual seal of approval based on exhaustive flame tests.



Jet Plane Hangar with HETRON skin for strength and fire safety can be erected and taken down rapidly, yet withstands winds up to 150 mph.

I. COMPARATIVE PHYSICAL CHARACTERISTICS

HETRON vs. 10 non-fire-retardant resins

property		rigid resins		semi-rigid resins	
		Hetron 92	avg. 10 others	Hetron 32A	Hetron 33
Flexural Strength, PSIx10^3	Room Temp.	38.6	36.4	41.8	40.9
	180°F	25.0	18.6	23.5	—
Flexural Modulus, PSIx10^6	Room Temp.	1.88	1.61	1.82	1.6
	180°F	0.90	0.79	0.85	—
Tensile Strength, PSIx10^3		21.7	22.0	21.0	21.5
Water Absorption, Pct. by Wt.		0.13	0.29	0.13	0.11

THIS TABLE summarizes tests on 0.1" laminates made from HETRON and from 10 other leading resins. Laminates contained 35-40% glass mat, 17-20% filler, and the balance resin.

II. TYPICAL PROPERTIES

HETRON 92 (rigid) and HETRON 32A (semi-rigid).

property	test temp.	HETRON 92	HETRON 32A
Flexural Strength, PSIx10^3	73°F	68.7	73.2
	160°F	55.1	40.9
After 2-hr. Water Boil	180°F	55.1	26.8
	73°F	59.8	52.8
Flexural Modulus PSIx10^6	73°F	3.1	3.2
	160°F	2.7	2.4
	180°F	2.5	1.9
Compressive Strength PSIx10^3	73°F	37.4	37.5
Tensile Strength PSIx10^3	73°F	40.4	40.4

THIS TABLE presents key properties of 1/8" laminates containing 40% resin and 60% glass fabric (OCF-181-Volan A).

retardant—specify HETRON® polyester

SELECTION GUIDE

type and no.	characteristics	suggested applications	typical properties resin, as supplied: viscosity, Gardner, @73°F poises	appearance	color	Sp. Gr., 73°F/73°F	SPI Gel Time, minutes	castings (cured without filler): flame retardance	shrinkage on cure, volume	heat distortion Pt., ASTM D648-45T	elongation at break	water absorption 7 days @73°F
rigid types: 92	Very high fire retardance; high heat distortion point; good resistance to water absorption. Low viscosity; low shrinkage.	Machine housings, electrical insulating board and parts, radomes, aircraft parts, structural panels, chemically resistant tanks and ductwork.	13-18	Clear	Light Straw	1.34	6	Self-exting.	6.1%	220°F	2.4%	0.26%
73	High heat distortion point; excellent heat resistance; good fire retardance. Low shrinkage on cure.	Aircraft parts and similar applications where good heat resistance is required.	23-27	Clear	Straw	1.30	4-5	Self-exting.	5.7%	288°F		
93LS	Light stabilized; excellent weathering characteristics. Same fire-retardant qualities as HETRON 92.	Skylights, explosion windows, industrial and commercial glazing where codes require a flame-resistant material.	5-6	Clear	Light Straw	1.30	5-6	Self-exting.		180°F		
72	High chemical resistance; excellent heat resistance; high heat distortion point.	Chemical tanks and ductwork; other high temperature applications.	13-18	Clear to Hazy	Straw	1.23	5-6.5	Self-exting.		300°F		
semi-rigid types: 32A	Excellent tensile strength and tensile elongation; excellent heat resistance. Laminates have good resistance to impact cracking.	Automotive and truck body panels and structural members, boat hulls and machine housings.	13-18	Clear	Straw	1.31	5-6	Self-exting.	6.4%	170°F	4.3%	
31	Exceptional resistance to cracking on rapid cure. Very high impact strength, retained at temperatures as low as —20° F.	Gel coats for hand lay-up parts, chemically resistant piping, boat covering kits.	9-11	Clear	Light Amber	1.28	5-6	Self-exting.	6.6%	120°F	7.6%	
33	Recommended for use where good impact strength is required. Excellent molding resin, especially for matched die moldings. Laminates are strong, stiff, and resist cracking even when baked several times at 350° F for 90 minutes.	Automotive and truck body panels and structural members, boat hulls and machine housings.	13-17	Clear	Light Straw	1.27	5-6	Limited	6.2%	183°F	4.3%	
flexible type: 42	Good tensile strength; 100% elongation at break; unusually low water absorption. Less fire-retardant than other HETRON resins.	For blending with other resins to increase flexibility.	13-18	Clear	Light Amber	1.23	7-8	See Note*	6.8%		100%	0.80%

*Not inherently self-extinguishing. Can be made self-extinguishing by adding 2.5% antimony trioxide.

DUREZ®

Plastics that fit the job

DUREZ PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

3200 Walck Road, North Tonawanda, New York

HOOKER CHEMICALS PLASTICS

Here's how (and why) wise processors use Diamond VINYL RESINS

Product	Specific Viscosity ASTM D-1243-52T	How to use	Why
DIAMOND PVC-50	0.44	Wire and Cable Insulation Profile Extrusions Calendered Film	Underwriters' Laboratories accepted as an interchangeable vinyl resin Excellent dry blending properties, high clarity and low gel particle count Superior heat stability A high molecular weight resin for optimum physical characteristics
DIAMOND PVC-45	0.38	Calendered Film and Sheeting Profile Extrusions Injection Moldings	Excellent dry blending, heat stability and clarity with low gel particle count Medium molecular weight offers easy processing
DIAMOND COMPOUND R-4		Type I Rigid PVC fittings, valves and pipe Calendered Rigid PVC Sheeting	Approved by National Sanitation Foundation Superior heat stability and easy processing characteristics permit use in conventional molding equipment Superior chemical resistance
Miscellaneous Plasticized DIAMOND PVC Compounds		For all types of extruded and molded products	Tailored compounds to meet customers' processing and end use requirements



Vinyl Processors like Diamond technical service, too

For two reasons: (1) our Plastics Products Laboratory evaluates and improves resins so that DIAMOND, and our customers, can make better products; (2) DIAMOND technical service is available to users, anywhere.

Only high quality can explain quick success in a hotly competitive market. DIAMOND technical service can help you put that quality to work in your products. We're ready to work with you now. Call your nearby DIAMOND sales office or write DIAMOND ALKALI COMPANY, 300 Union Commerce Building, Cleveland 14, Ohio.

Diamond Chemicals



Catalin

Industry's Dependable Quality-Source for Industrial Resins and Molding Compounds!

CATALIN molding and extrusion compounds . . . Styrene, Polyethylene and Nylon . . . each available in a wide range of formulations, figure prominently in the end-use product progress being made by today's plastics industry.

Of equal importance is the pioneering role that CATALIN has played in the research and development of urea, phenolic, cresylic, resorcinol and melamine resin formulations for industrial processes. Furniture, plywood, structural timbers and particle boards have achieved new usefulness because of CATALIN adhesives. Industrial and decorative laminates; rock wool and glass fibre insulations; crease resistant textiles; wet strength papers—all owe their improved properties to CATALIN bonding and impregnating resins. So, too, do grinding wheels and abrasive papers; brake linings; clutch facings; cork sheets; rods and tubes; oil filters; foundry shell molds and cores.

The immediate availability of CATALIN Molding Compounds, Industrial Resins and the newer Antioxidants, too, is a CATALIN-customer satisfaction factor. Thru the operation of three plants in the East, Midwest and South . . . and via strategically spotted warehouse facilities . . . supply requirements keep apace of nationwide demand. Result?—an excellent industrial relationship . . . a *mold-and-bond* that daily grows stronger.

CATALIN CORPORATION OF AMERICA
ONE PARK AVENUE • NEW YORK 16, N. Y.

Catalin



Save on wall thickness!
Because of the greater strength of Marlex 50 compared to conventional polyethylene, less resin is required to achieve desired rigidity in any item.

Marlex* 50 Gives You More Items Per Pound of Resin

MARLEX makes it possible for you to manufacture stronger products from less material . . . and because MARLEX sets up at higher temperature, you can achieve faster production. These are important manufacturing economies.

Greater strength, greater ability to withstand heat and cold, superb resistance to penetration by moisture, gases, oils and chemicals . . . all these qualities make possible the manufacture of many new and better products from MARLEX. Write your nearest Phillips Chemical Company office for further details.

*MARLEX is a trademark for Phillips family of olefin polymers

MARLEX 50
Phillips New, Rigid
POLYETHYLENE

PLASTICS SALES DIVISION
PHILLIPS CHEMICAL COMPANY
A Subsidiary of Phillips Petroleum Company, Bartlesville, Okla.

DISTRICT OFFICES

NEW ENGLAND
322 Waterman Avenue,
East Providence 14, R. I.
GEneva 4-7680

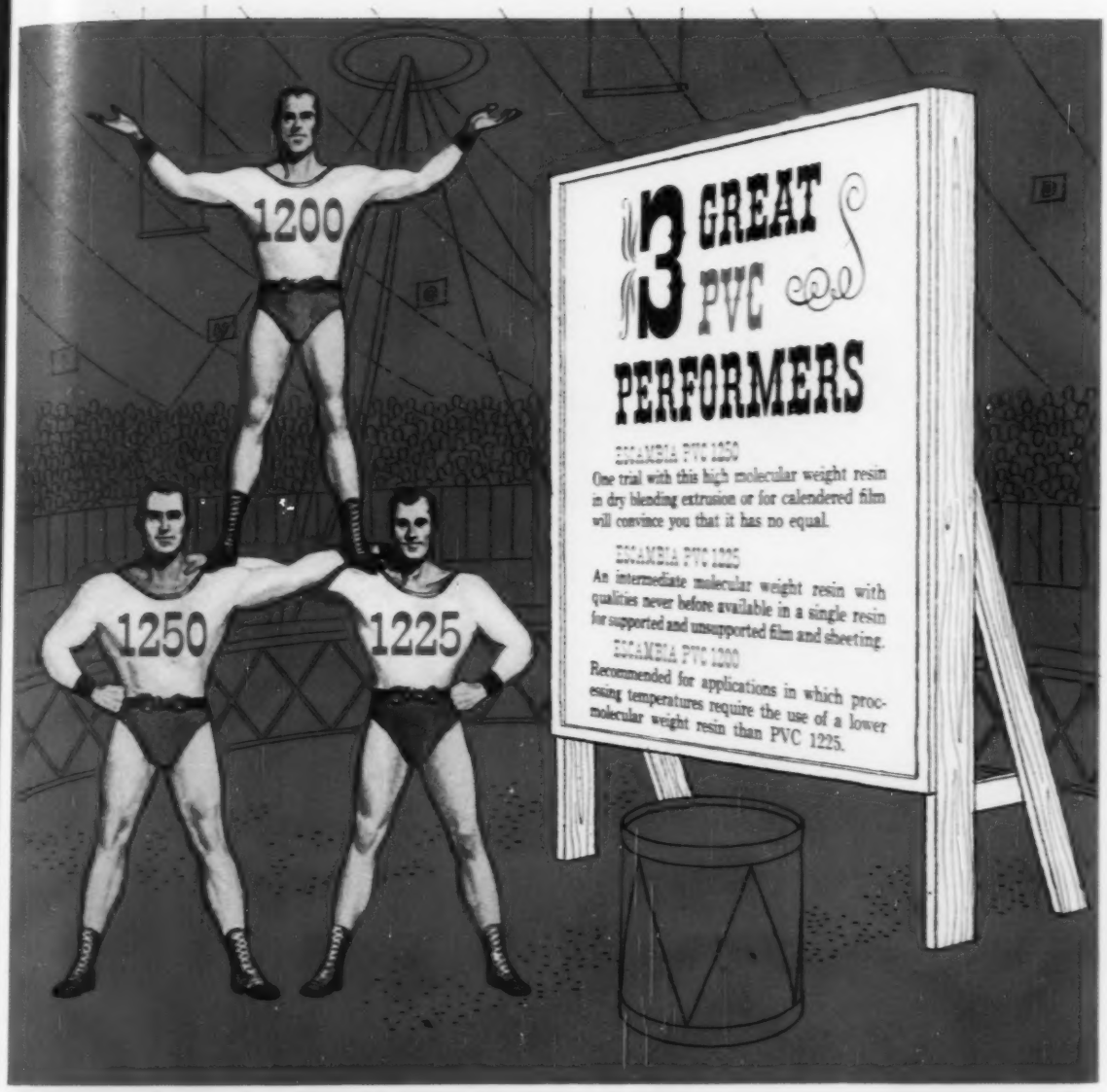
AKRON
318 Water Street,
Akron 8, Ohio
FRanklin 6-4126

WESTERN
330 Security Bldg.,
Pasadena, Calif.
RYan 1-6997

NEW YORK
80 Broadway, Suite 2535
New York 5, N. Y.
Digby 4-3480

CHICAGO
111 S. York Street,
Elmhurst, Ill.
TErrace 4-6680

SOUTHERN & FOREIGN
Adams Building,
Bartlesville, Oklahoma
Bartlesville 6600



Whether your product calls for high, medium or low molecular weight resins—the outstanding properties of Escambia's series of Straight PVC resins will save you processing time and costs:

- Outstanding Heat Stability
- Very Low "Fish Eye" Count
- Free-Flowing Hot Pre-Mixes
- Uniform Particle Size
- Excellent Color and Clarity

For additional information about Escambia's Straight PVC Resins—write or call:

ESCAMBIA CHEMICAL CORPORATION

261 MADISON AVENUE • NEW YORK 16, N. Y.

WHAT DO YOU MAKE OF THIS?



TENTATIVE PROPERTY CHART

PHYSICAL PROPERTIES	VALUE	UNITS	ASTM TEST METHOD
Melt Index	0.7	—	D 1238-52T
Specific Gravity	0.96	—	—
Hardness, Shore D	70	—	—
Tensile Strength at yield (20"/min. CHS)	4500	psi	D 638-52T
Tensile Elongation at break (20"/min. CHS)	40	%	D 638-52T
Heat Distortion Temp. (66 psi fiber stress)	175	°F	D 648-45T
Impact Strength, (¼ x ½ in. notched bar, Izod test)	7.0	ft-lb/in	D 256-54T
Brittleness Temp.	<—106	°F	D 746-55T
Stiffness	130,000	psi	D 747-50
Tensile Modulus of Elasticity (x10⁻⁴)	0.09	psi	D 638-52T
Flexural Modulus of Elasticity (x10⁻⁴)	0.20	psi	D 790-49T
Water Vapor Transmission Rate	0.25	g/100 sq in/mil/24 hrs	E 96-53T Proc. E, 100°F, 90% R.H.
Mold Shrinkage-Injection	0.02-0.04	in/in	D 955-51
Burning Rate	0.9-1.0	in/min	D 635-44

ELECTRICAL PROPERTIES	VALUE	UNITS	ASTM TEST METHOD
Volume Resistivity	10^{16}	ohm-cm	D 257-54T
Dielectric Strength (short time, ⅛ in. thickness)	550	v/mil	D 149-55T
Dielectric Constant (60 cps)	2.3	—	D 150-54T
Dielectric Constant (10^3 cps)	2.3	—	D 150-54T
Dielectric Constant (10^6 cps)	2.3	—	D 150-54T
Dissipation Factor (tan d @ 60 cps)	<.0005	—	D 150-54T
Dissipation Factor (tan d @ 10^3 cps)	<.0005	—	D 150-54T
Dissipation Factor (tan d @ 10^6 cps)	<.0005	—	D 150-54T
CHEMICAL and SOLVENT RESISTANCE			
Effect of Weak Acids	Very resistant	—	D 543-52T
Effect of Strong Acids	Very resistant	—	D 543-52T
Effect of Oxidizing Acids	Stiffened	—	D 543-52T
Effect of Weak Alkalies	Very resistant	—	D 543-52T
Effect of Strong Alkalies	Very resistant	—	D 543-52T
Effect of Organic Solvents	Slightly soluble in hot hydrocarbon solvents	—	D 543-52T
MISCELLANEOUS			
Ash	<.01	%	D 229-49
Machining Qualities	Excellent	—	—
Clarity	Translucent	—	—

This literature is submitted with the understanding that it represents our best judgment based on the work done but that the Company assumes no liability whatsoever in connection with the use of information or findings contained here



GREX*

*TRADEMARK FOR W. R. GRACE & CO.'S POLYOLEFINS

W. R. GRACE & CO.
POLYMER CHEMICALS DIVISION

Plant
Baton Rouge, La.

Offices
Clifton, N. J.

This ponderous machine, invented by one of our artists, not our engineers, may not be very practical but it does help us to illustrate the great versatility of GREX, the high density polyethylene. This versatility offers to molders, extruders and fabricators properties not found in other plastics. The unusual strength, high heat resistance, and exceptionally low moisture vapor transmission rate of GREX make it ideal for numerous applications both current and new. What can you make of this? Write today for more specific information.

Looking for finest quality polyvinyl chloride resins?

Check GREAT AMERICAN PLASTICS.
Plant at Fitchburg, Massachusetts, is equipped with most up-to-date facilities, including extensive quality control equipment.
You'll want complete information about IRVINIL, too—a specially developed polyvinyl chloride.

Write for prices and details.

GREAT AMERICAN PLASTICS COMPANY

Petro Chemical Division

650 Water St. Fitchburg, Mass.



a *NEW*

MOLDING COMPOUND

Announcing a new thermosetting, general-purpose, molding compound, possessing excellent strength, finish and moldability. Furnished in various degrees of flow and cure, it is designed for straight compression, transfer or plunger molding.

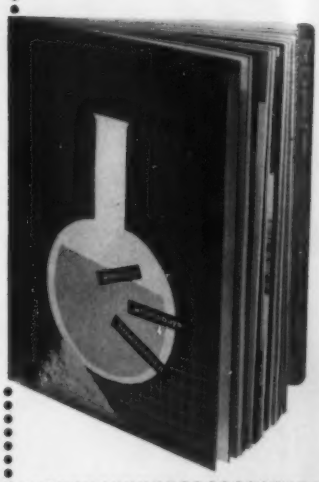
The unique modified phenolic-type resin, from which these molding compounds are produced, can also be supplied separately. Derived from bagasse, an agricultural by-product, it offers economies to compound manufacturers as a substitute for their present binder.

Valite
REG. U. S. PAT. OFF.
INDUSTRIAL RESINS

Thermoplastic Resins for
VINYL COMPOUNDS
STYRENE COMPOUNDS
RUBBER REINFORCERS
PLASTIC COATINGS
Thermosetting Resins for
SHELL MOLDINGS
LAMINATES

VALITE CORPORATION 727 WHITNEY BLDG. NEW ORLEANS 12, LA.

How to figure your sales potential in the plastics field



FREE . . . 40 page brochure will help you find answers to your questions about sales opportunities in the fast-growing plastics field.

This new study contains the inside story of one of America's fastest growing industrial markets. It presents one of the most stimulating and detailed analyses of the plastics field that has yet been published. It's filled with up-to-date figures on the consumption and production of plastics materials, on the field's processing equipment requirements, on potential areas of growth. It lists hundreds of kinds of machines, accessories, chemicals and intermediates, supplies and special services for which the field is manifesting an ever-increasing appetite.

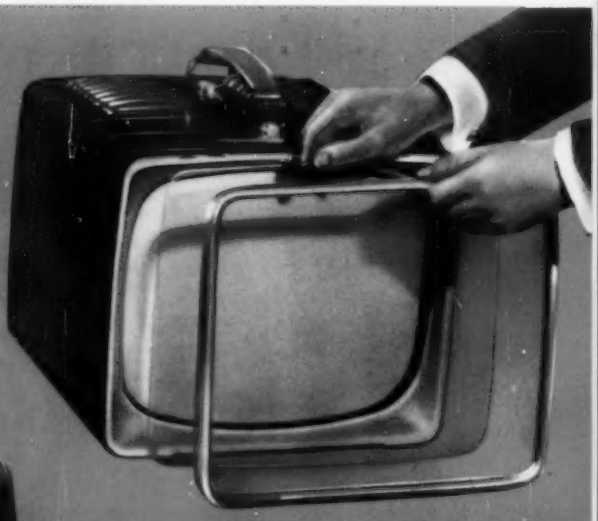
You will find this handsome brochure—file size, lavishly illustrated, 40 pages—a valuable addition to your business library. It may well point the way to increased sales for the industrial products or services that your firm supplies.

For your free copy of "The Plastics Field," simply address a note on your company letterhead to *Advertising Manager*, Modern Plastics, 575 Madison Avenue, New York 22, N. Y.

PLEXIGLAS molding powders



AUTOMATIC WASHER CONTROL PANELS



TELEVISION SET TUBE SHIELDS



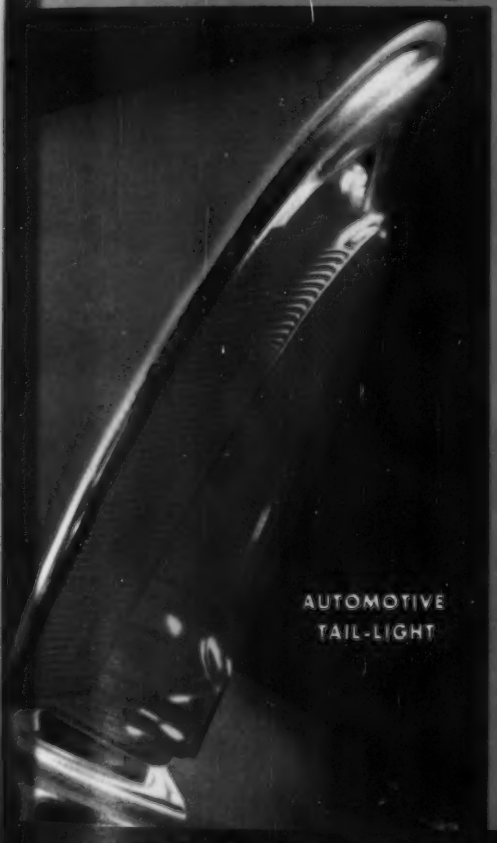
SHOE HEELS



CAMERA LENSES



STEERING POST MEDALLIONS



AUTOMOTIVE TAIL-LIGHT



ELECTRIC SHAVER HOUSINGS



BILGE PUMP HOUSINGS



DISPLAY NAME PLATES

ROHM & HAAS COMPANY • PHILADELPHIA 5, PA.

PLEXIGLAS MOLDING POWDERS

PLEXIGLAS is the trademark for acrylic plastic molding powders manufactured by Rohm & Haas Company. Because of the combination of gleaming beauty and rugged durability inherent in acrylic plastic, PLEXIGLAS is used to give added sales appeal and serviceability to a wide range of products. Manufacturers of cars, home appliances, lighting fixtures, personal accessories, and optical and electrical equipment have found that parts molded of PLEXIGLAS provide the answer to their most exacting decorative and functional requirements. These pages tell why.

Characteristics of Molded Parts



CLARITY

Transparent moldings like this edge-lighted automobile indicator panel are crystal clear. Because of this freedom from cloudiness or haze, maximum efficiency is obtained in light-piping and other optical effects.

BRILLIANT APPEARANCE

Plexiglas molded parts have bright, lustrous, sparkling surfaces that enhance the colorful appearance of three-dimensional insignia and name plates.

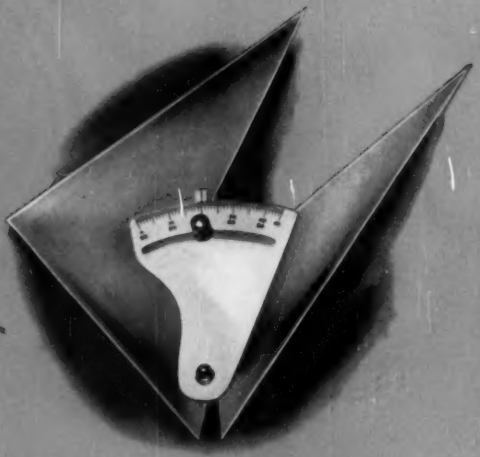
WEATHER RESISTANCE

Because Plexiglas is an acrylic plastic, unique among all plastics in ability to withstand exposure to weather, molded parts such as this exterior sign letter give long trouble-free service in outdoor applications. A wide range of colored powders are available, developed especially for outdoor stability.



DIMENSIONAL STABILITY

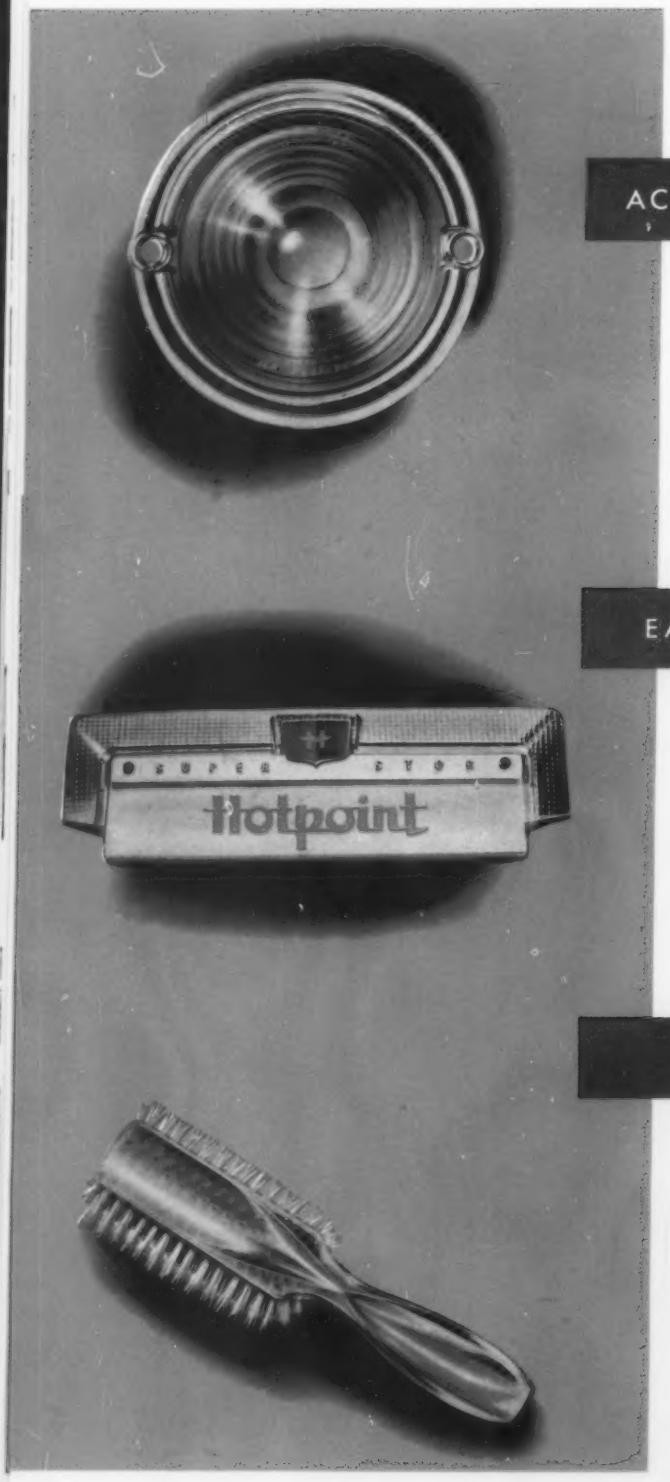
Plexiglas molded parts are notable for their freedom from shrinking or deterioration through long periods of use. The molding powders contain no plasticizers to leach out and have relatively low water absorption characteristics. Many types of precisely calibrated drafting instruments, where dimensional stability is essential, are molded of Plexiglas.



BREAKAGE RESISTANCE

Plexiglas imparts resilience and high impact strength to molded parts, enabling them to withstand hard blows and remain undamaged under rigorous service conditions. Tail light lenses on most motor cars are molded of Plexiglas.





ACCURACY OF MOLDING

Precise contours and sharp angles in molded parts such as automobile lenses are achieved with maximum efficiency by using Plexiglas. Molding accuracy can be sustained throughout large production runs.

EASE OF DECORATION

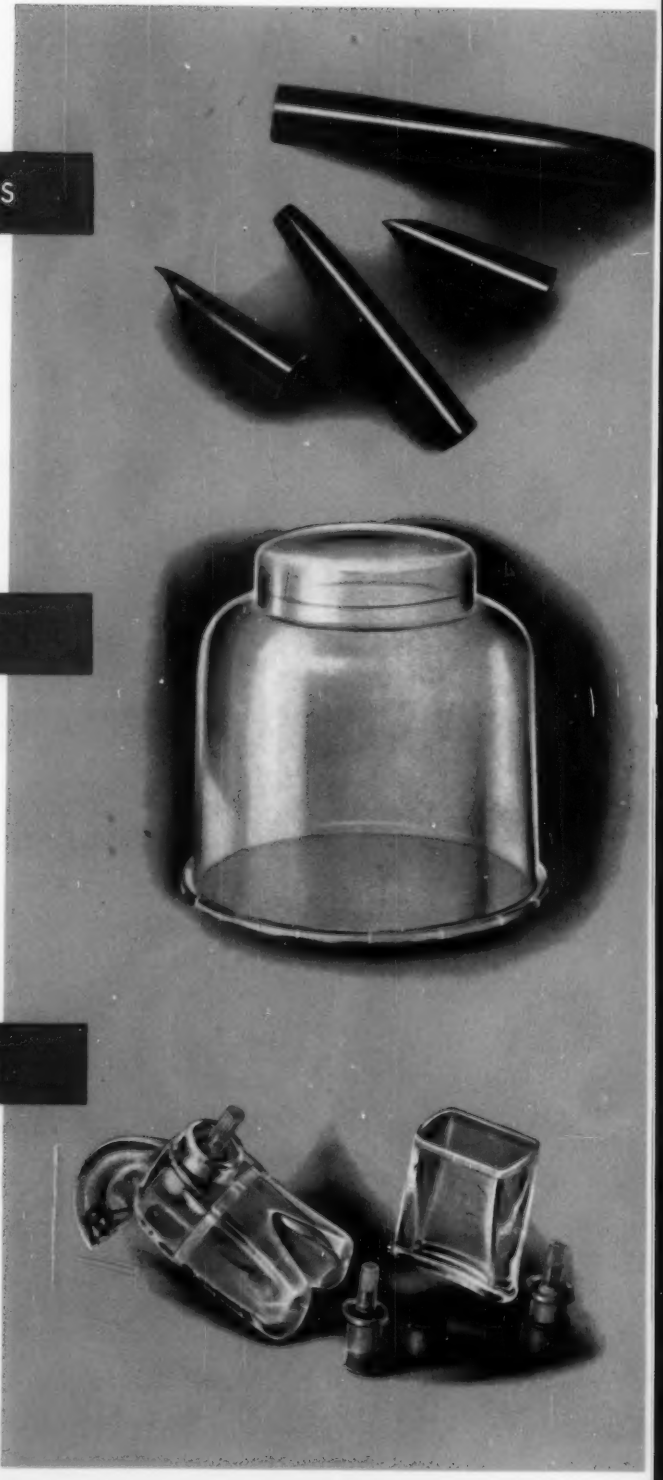
Paints and vacuum metallized coatings can be applied to parts molded of Plexiglas, resulting in efficient, high-yield production of three-dimensional, multi-colored parts such as trademark insignia.

MACHINEABILITY

Molded parts can be machined, drilled, threaded or routed with accuracy whenever such finishing operations are required. Multiple drilling of bristle holes in brush backs, for example, is performed without difficulty.

CHOICE OF COLORS

For integrally colored moldings such as fountain pen and pencil housings, a complete range of standard transparent, translucent, and opaque colored Plexiglas molding powders are available. Custom-matched shades are produced for special color requirements on volume orders.

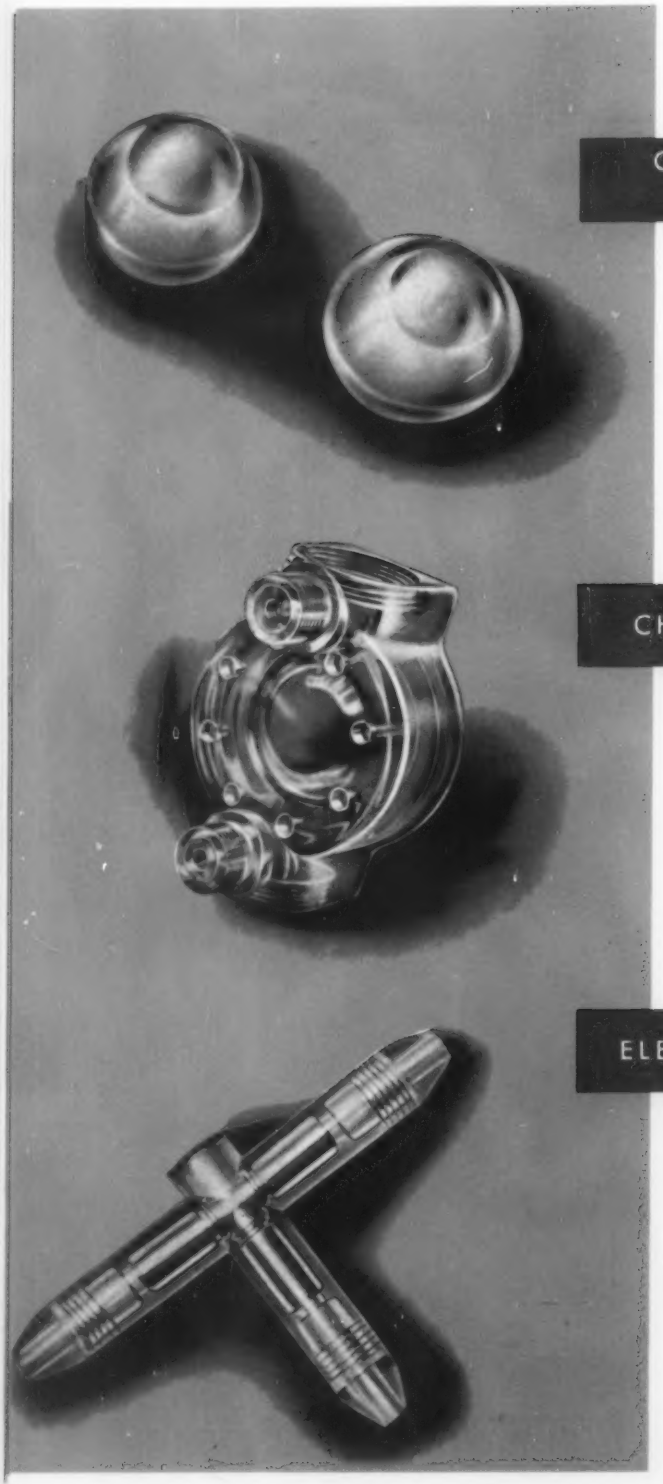


TASTEFREE

Plexiglas molded parts are free of taste, and are used for various types of food and beverage containers such as this bowl of a fruit juice dispensing machine.

ODORLESS

Lack of odor is one of the reasons parts molded of Plexiglas are preferred for personal accessories, and articles such as this inhalator.



COMPATIBILITY WITH HUMAN TISSUE

Sensitive human tissue is not harmed by contact with Plexiglas moldings. Contact lenses are a typical example of applications where this characteristic is of particular advantage.

CHEMICAL RESISTANCE

An organic resin, Plexiglas is not affected by alkalies, non-oxidizing acids, salt water, photographic solutions, and chemicals used in treating water. It is attacked by alcohol, strong solvents, and fire extinguishing solutions. This valve is molded of Plexiglas because it must resist the corrosive effects of gaseous chloride.

ELECTRICAL INSULATION

Plexiglas molded parts are excellent insulators, with good resistance to arcing. Prolonged exposure to weather, or immersion in water, has practically no effect on electrical properties. This Plexiglas aircraft antenna fitting also permits easy inspection of antenna connections.

PLEXIGLAS MOLDING POWDERS...

AVERAGE PHYSICAL PROPERTIES...

PLEXIGLAS is a trademark Reg. U.S. Pat. Off. and other principal countries in the Western Hemisphere

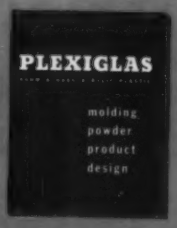
		Average Values (not intended for specification purposes)			
		Injection	Injection	Injection	Compression
Property	Test Conditions	PLEXIGLAS VS	PLEXIGLAS VM	PLEXIGLAS V	PLEXIGLAS Y
Refractive Index	A.S.T.M. D-542-42 —	1.49	1.49	1.49	1.49
Specific Gravity	A.S.T.M.D.-792-44T —	1.18	1.18	1.19	1.19
Tensile Strength	A.S.T.M. D-638-46T ¼" specimen (0.2"/min.) Maximum, psi.	8000	9000	9000	7000
Flexural Strength	A.S.T.M. D-790-45T Span-depth ratio 16 (0.1"/min.) Maximum, psi.	15,000	16,000	16,000	12,000
Compressive Strength	A.S.T.M. D-695-44T (0.2"/min.) Maximum, psi.	14,500	15,000	17,000	12,000
Impact Strength	A.S.T.M. D-256-47T Izod Molded Notch (per inch of notch) ft. lbs.	0.5	0.4	0.4	
Rockwell Hardness	R & H P-20 ¼" Ball, 100 Kg. Load	M—80	M—84	M—92	M—62
Light Transmission "As Received"	A.S.T.M. D-672-42T Total White, %	93	93	93	93
Effect of Accelerated Weathering on Appearance of Clear Material	LP 406b-6021 (240 hours) Crazing Discoloration Warping Unmolding	None None None None	None None None None	None None None None	None Yellowed Slightly None None
Heat Distortion Temperature	A.S.T.M. D-648-45T 2°C./min.-264 psi.	75°C. (167°F.)	80°C. (176°F.)	91°C. (196°F.)	67°C. (153°F.)
Flow Temperature	A.S.T.M. D-569-48 —	132°C. (270°F.)	140°C. (284°F.)	158°C. (316°F.)	145°C. (293°F.)
Shrinkage from Mold Dimension	A.S.T.M. D-551-41 modified (Cold mold to cold piece) mils/in. 48 hrs.	4—7	4—8	5—8	
Deformation under Load	A.S.T.M. D-621-48T 2000 psi., 24 hrs. @ 50°C., percent	0.4	0.3	0.3	
Dielectric Strength	A.S.T.M. D-149-44 Volts/mil	500	500	500	500
Dielectric Constant	A.S.T.M. D-150-47T 1,000,000 cycles	2.3	2.3	2.2	3.0
Power Factor	A.S.T.M. D-150-47T 1,000,000 cycles	0.03	0.03	0.03	0.02
Loss Factor	A.S.T.M. D-150-47T 1,000,000 cycles	0.08	0.08	0.06	0.06
Arc Resistance	A.S.T.M. D-495-48T —	No Tracking	No Tracking	No Tracking	No Tracking
Flammability	A.S.T.M. D-635-44 Burning Rate, in./min.	0.5	0.6	0.7	0.7
Odor	—	None	None	None	None
Taste	—	None	None	None	None
Water Absorption	A.S.T.M. D-570-42				
	Wt. gain on 24 hours water immersion	0.3	0.3	0.3	0.3
	Dimensional change on immersion, percent	None	None	None	None

TYPES OF MOLDING POWDERS

Injection

Extrusion

Compression



This brochure contains detailed information on the design and use of molded PLEXIGLAS parts. It will be sent promptly on request. Ask for Booklet PL-159a.



This manual—Design and Fabrication Data—covers fabrication techniques and design considerations involved in the use of cast PLEXIGLAS sheets. For copies, ask for Booklet PL-28d.

CAST AND EXTRUDED SHEETS

PLEXIGLAS acrylic plastic is also made in the form of cast and extruded sheets in a wide range of sizes and thicknesses, as clear transparent material and in many colors. Sheets can be heated and formed to almost any shape and are easy to cut, machine and cement. They have the same advantageous performance characteristics as parts molded from PLEXIGLAS molding powders. Because of this, sheets are useful for prototypes of parts to be molded, design study models, transparent demonstration models, and for production runs in quantities where tooling costs for molding are not justified.

DESIGN SERVICES AVAILABLE

Services of the design staff of the Rohm & Haas Company Plastics Laboratory are available for consultation in the design of molded parts and sheet applications. For assistance in any idea or problem involving the use of PLEXIGLAS, call or write the nearest of the following sales offices:

1430 W. Peachtree Street, N.W. . . . . Atlanta 9, Georgia
13 Eaton Court, Wellesley Hills . . . . . Boston 82, Massachusetts
5750 W. Jarvis Avenue, Niles . . . . . Chicago 31, Illinois
2012 W. 25th Street . . . . . Cleveland 13, Ohio
209 Browder Street . . . . . Dallas 1, Texas
410 West First Street . . . . . Dayton 2, Ohio
20211 Greenfield Road . . . . . Detroit 35, Michigan
1009 Baltimore Avenue . . . . . Kansas City 5, Missouri
5657 Wilshire Boulevard . . . . . Los Angeles 36, California
350 Fifth Avenue . . . . . New York 1, New York
600 California Street . . . . . San Francisco 8, California
1110 S. Brentwood Boulevard . . . . . St. Louis 17, Missouri
734 Fifteenth Street, N.W. . . . . Washington 5, D. C.

Canadian Distributor:

Crystal Glass and Plastics, Ltd., 130 Queen's Quay, East, Toronto, Ontario, Canada

PLEXIGLAS is a trademark Reg. U. S. Pat. Off. and other principal countries in the Western Hemisphere

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Printed in U. S. A.



In PLASTICS, the plant that does everything!

THESE PRODUCTS:

GERING "the Hose with the Mirror Finish."

GERLITE Extruded Acrylic Sheets, clear or colored, to 54" wide, to .125" thick, any practical length. For Illuminating Signs, Lighting Fixtures and Vacuum Forming Applications.

GER-FLEX Vinyl Tubing

GER-TUBE Polyethylene Tubing from 1/32" to 4" I.D., also special shapes and cross-sections.

DRYCOL on-the-spot, in-plant colorant for all thermoplastics.

S-T-R-E-T-C-H Polyethylene master-batch color concentrate.

STYROMIX Clear polystyrene dry-blended with color and lubricants, ready to mold.

GER-PAK Polyethylene film, sheeting, and tubing for packaging consumer and industrial products. Moisture-vapor barrier up to 20 feet wide, for use in light and heavy construction.

THESE SERVICES:

Molding Powders Division

We manufacture for standard and special applications, for injection and extrusion molding:
Polystyrene • Vinyls • Polyethylene
Cellulose Acetate • Ethyl Cellulose
Acrylic • Nylon

Extruded Products Division

Complete Department equipped with extruders from 2" to 10" with dies and take-off equipment to make Sheeting, Tubing, Rods, Pipe, Special Cross Sections and Shapes.

Custom Compounding

Complete facilities for top quality processing. Full staff of laboratory, technical and engineering personnel.
Polyethylene • Vinyls • Nylon • Acrylic • Cellulose Acetate • Butyrate Ethyl Cellulose • Polystyrene and its Copolymers

SCRAP RECLAMATION

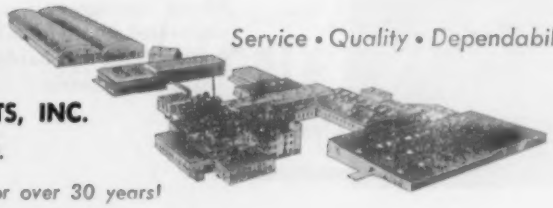
Far ahead of any ordinary scrap reclamation is the job done at Gering. Our long experience coupled with skilled technical personnel enables us to work wonders with scrap sorting, separating, grading, decontaminating, blending, color matching, compounding, and pelletizing.

GERING

PRODUCTS, INC.

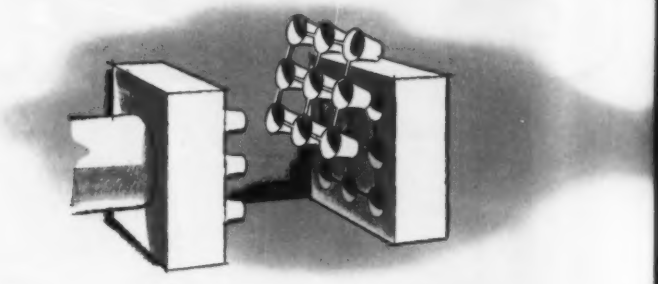
KENILWORTH, N. J.

Pioneers in modern plastics for over 30 years!



Service • Quality • Dependability

VYGEN®



MOLDING

VYGEN 105

VYGEN 110

VYGEN 120

VYGEN 1101

VYGEN 2201

VYGEN 105—A lower molecular-weight resin for molding, calendering, and extrusions requiring a high-gloss finish. Especially well-suited for high-gravity light-embossed calendered sheeting. VYGEN 105 allows the use of lower processing temperatures.

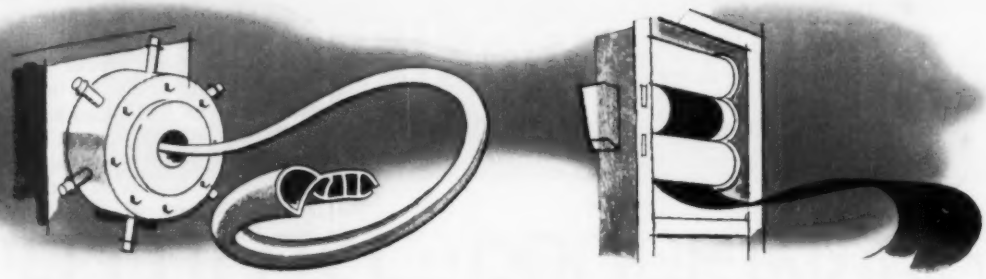
VYGEN 110—A general-purpose, average-molecular-weight resin, adapted for easy processing of calendered film, sheeting and coated fabrics. Also recommended for molding and extruding operations where excellent heat and light stability are requirements.

VYGEN 120—A high-molecular-weight, general-purpose resin, ideally suited for dry-blend extrusion operations . . . blended with monomeric or polymeric plasticisers, this resin has an extremely rapid rate of solvation. VYGEN 120 has a narrow range of particle size distribution, producing extrusions free of gelled particles.

VYGEN 1101—A Type I rigid PVC compound for extrusion . . . comes ready for the extruder, offering a perfect balance between optimum chemical resistance and easy processing.

VYGEN 2201—A modified rigid PVC compound produced for calendering operations . . . easily processed on existing equipment. Can be pigmented for light colors, and has excellent flame resistance, high flexural modulus and hardness. Sheet is easily post-formed by deep drawing or vacuum forming.

The "FIRST FAMILY" of specialized PVC resins for specific application



EXTRUDING CALENDERING

General's Chemical Division foresaw the need in the plastics industry for specialized resins to meet specific requirements. Combining modern research methods with production "know how", the VYGEN family of top-quality PVC resins has been developed and tested to satisfy that need. No longer must you "take the closest thing"... now there's a VYGEN resin *just right* for *your* application, and delivery will fit the most demanding production schedules. To guarantee the finest finished product, select the VYGEN resin designed for your job . . . or write the Chemical Division for assistance.

THE GENERAL TIRE & RUBBER COMPANY
CHEMICAL DIVISION • AKRON, OHIO

Creating Progress Through Chemistry

Chemical Division GENERAL
THE GENERAL TIRE & RUBBER CO. VYGEN

New!

SOFT SELF CURING ACRYLIC

Powder and liquid ratio regulates the hardness. Pressed into the desired form it self polymerizes to an elastic resin. It could be used for many applications where a rubbery resin is desired.

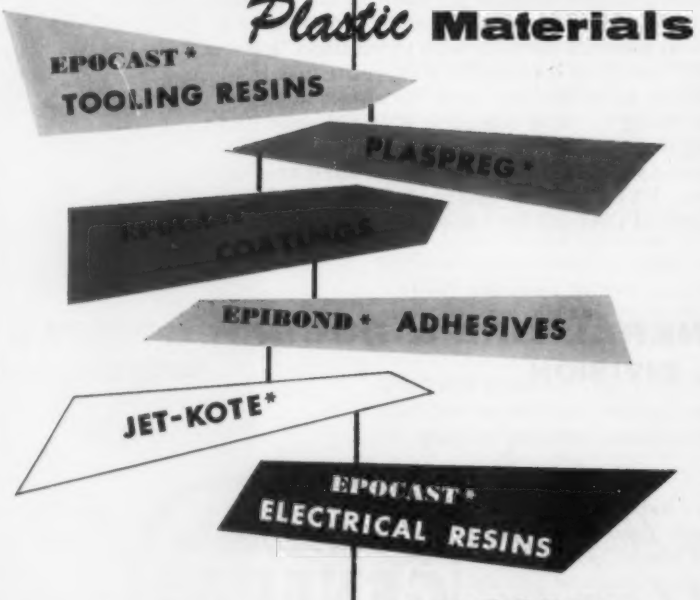
IMPROVED

HARD Self curing Acrylic. It is more brilliant and clearer.

ETHYL methacrylate ultra fine polymer and copolymers of acrylic to use with tailor made monomers, forming elastic resins.

PETERS CHEMICAL MFG. CO.
3623 Lake Street, Melrose Park, Ill., Fillmore 4-0643

A Perfect Balance of *Plastic* Materials



4516 Brazil St. Los Angeles 39, Calif.

furane plastics INCORPORATED

* REGD. T.M.

FREE

TO SUBSCRIBERS

Modern Plastics' Annual Editorial Index

(Index to Volume 34, September 1956 through August 1957)

You will find this extensively cross-referenced, sixteen-page Index a welcome time saver in locating editorial material that has appeared in a full year's back issues of the magazine. More than that, you'll discover that the Index increases the value of your file copies by providing a considerably more detailed breakdown of their contents—particularly of "buried" references within an article—than is given on the "Contents" page of individual issues.

The Cumulative Index is actually three indexes in one: a General Index of Titles, an Index of Individual Subjects and an Index of Authors.

The General Index of Titles is further subdivided into separate indexes of engineering and technical articles, and the Index of Individual Subjects alphabetically cross-tabs plastics product applications in two ways: by material of composition and by product name.

To get your copy, just fill out and mail the coupon

Modern Plastics,
575 Madison Ave.,
New York 22, N. Y.
Gentlemen:

Please send my free copy of MODERN PLASTICS' Editorial Index for Volume 34.

Subscriber's name .....

Company .....

Address .....

City .....

State .....

Celanese . . . THE FIRST NAME IN PLASTICS

POLYOLEFIN THERMOPLASTIC

CELLULOSE ACETATE

CELLULOSE PROPIONATE

POLYESTER RESINS

ACETATE FILMS

ACETATE SHEETING

PVAc RESINS

CELANESE CORPORATION OF AMERICA, Plastics Division, Dept. 101 X, 744 Broad Street, Newark 2, N.J.

ACETATE MOLDING COMPOUNDS

DESCRIPTION

Celanese acetate combines high impact, tensile and flexural strength, shatter resistance, color permanence and freedom from objectionable odor. The material molds and extrudes readily with a high gloss finish. Available in a range of formulations and colors.

APPLICATIONS

Toys, shoe heels, appliance housings, jewelry, tool handles, sunglasses, brush backs.

FORTICEL MOLDING COMPOUNDS

DESCRIPTION

Forticel (cellulose propionate) offers an excellent balance of physical and mechanical qualities . . . good form retention, dimensional stability, high impact and tensile strength, weathering characteristics, unusually fine moldability, and freedom from unpleasant odor. Available in a number of formulations and range of colors.

APPLICATIONS

Pens, telephone housings, automotive parts, optical frames, business machine keys, vacuum cleaner attachments, transistor set cases.

MARCO POLYESTER RESINS

DESCRIPTION

Thermosetting liquid resins adaptable to a variety of fabricating techniques. Available in a number of formulations which can be blended to acquire specific physical properties in finished products. Tack-free cures at ordinary room temperatures. Cured Marco Resins exhibit excellent resistance to moisture, heat, weathering, and most chemicals. Special thixotropic formulations for hand lay up fabrication. Premix formulations based on MR Polyester Resins are also available.

APPLICATIONS

For boats, auto bodies, corrugated and flat sheet, housings, tank and tank linings, swimming pools, truck bodies, miscellaneous laminates, castings and coatings.



ACETATE SHEETING and FILM

DESCRIPTION

Celanese acetate sheeting and film offer crystal clarity, flatness, water and grease resistance, moisture vapor permeability, and excellent aging characteristics. Available in thickness from .0005" to 0.250"—continuous lengths and cut sheets —clear transparent, transparent tints, opaque colors and special effects.

APPLICATIONS

Ophthalmic frames, lamp shades, advertising displays, crystals, safety shields, goggles, visible office records, protective covers. For packaging of all types including vacuum formed and fabricated rigid transparent containers, backing for pressure sensitive tapes, sound recording tapes, metallic stamping foils, electrical insulation, and vacuum metallizing.

PVAc RESIN EMULSIONS

DESCRIPTION

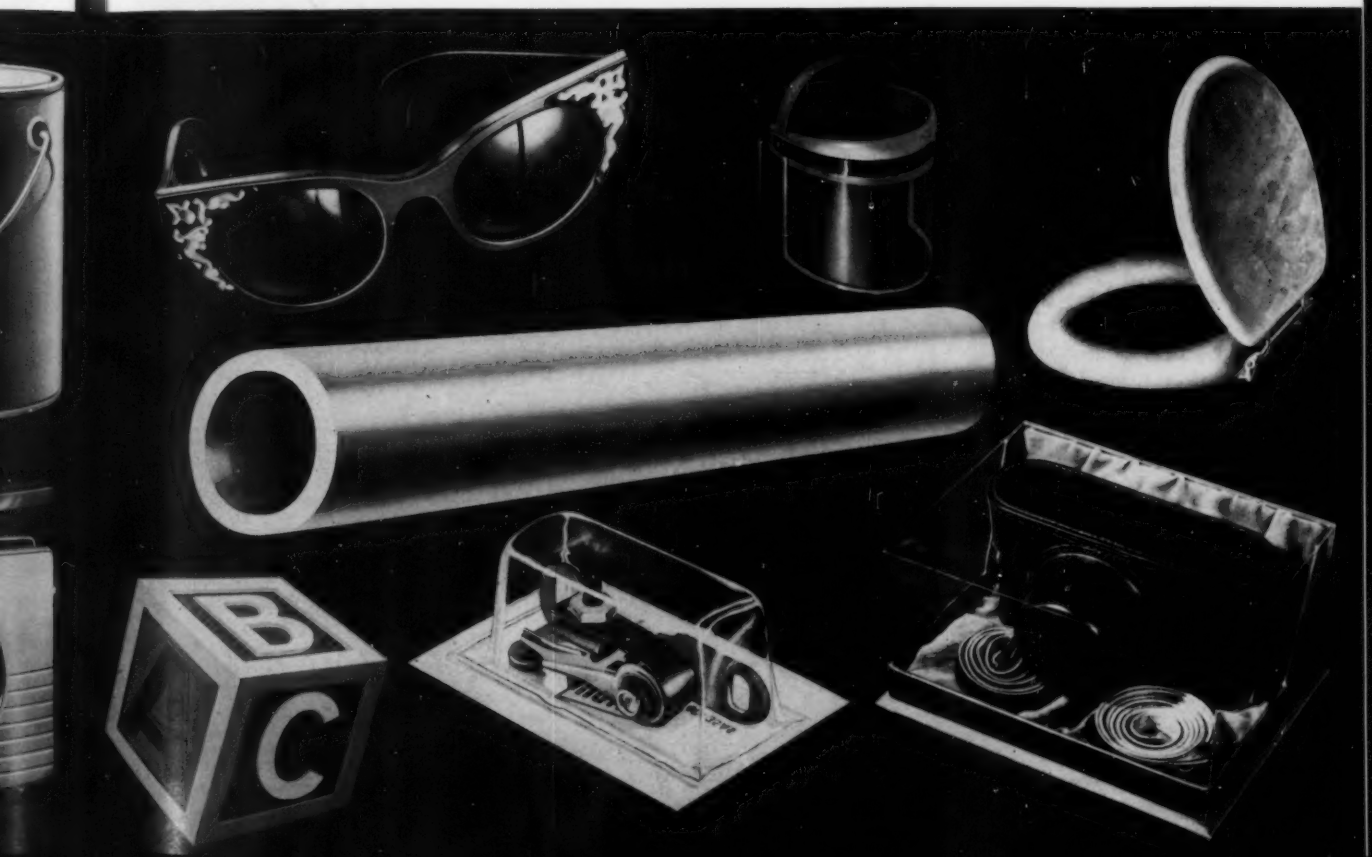
Celanese polyvinyl acetate emulsions are milk white liquids with viscosities ranging from water-thin to extremely viscous. They are characterized by small particle size, excellent film strength and clarity. They are available as homopolymers and copolymers.

APPLICATIONS

Water-based latex paints for both interior and exterior use . . . adhesives . . . textile coatings and finishes.

FORTIFLEX A a new polyolefin thermoplastic

Fortiflex A is characterized by its toughness, rigidity and chemical resistance. Products made of this readily moldable thermoplastic exhibit excellent resistance to sterilization temperatures and flexibility at low temperatures. Applications include: bottles and containers, housewares, toys, sporting goods, packaging materials, and transportation, industrial and electrical products.



FORTIFLEX

high-density linear polyolefin plastic

Fortiflex A, a new Celanese thermoplastic, is a high-density polyolefin plastic produced by low-temperature, low-pressure process.

This process produces polymers having linear chains with less branching than conventional polyethylene, resulting in:

- **improved rigidity with greater strength**
- **harder surface with excellent surface finish**
- **lower permeability to moisture and most gases**
- **ability to withstand from below zero to sterilization temperatures**

Furthermore, the fine qualities that have made polyethylene the outstanding plastic of this decade are inherent in Fortiflex A:

- **resistance to chemical attack**
- **excellent electrical characteristics**
- **colorability, moldability, economy**

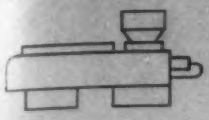
These properties, plus the fact that this plastic type has sanction by the Food and Drug Administration for use in contact with food, promise Fortiflex A a major role in housewares; packaging; refrigerator parts; toys; gears, housings and parts; medical equipment.

Fortiflex A is available now in commercial volume from conveniently located terminals in major industrial areas. Write Sales Development Department, Celanese Corporation of America, Plastics Division, 290 Ferry Street, Newark 5, N. J., for complete details.

Celanese PLASTICS

Celanese® Forticel® Marco® Fortiflex®





MOLDING



PROTECTIVE COATING



TEXTILE FINISHING

BCI NYLON RESINS SERIES 800

THE MOST VERSATILE NYLONS EVER PRODUCED!

Used in extrusion, injection or compression molding, water dispersion or solvent solutions.

- **thermoplastic or thermosetting**
- **flexible without plasticizers**
- **high strength and elasticity**
- **barrier to hydrocarbon solvents**
- **exceptional abrasive resistance**
- **heat sealable**

Look for forthcoming news of BCI's expanding range of nylon resins for extrusion as well as injection molding.

Should additional data on BCI nylon resins be desired, we will welcome your inquiry:

BELDING BCI CORTICELLI INDUSTRIES

1407 BROADWAY, NEW YORK 18, N.Y.



To commemorate

25 YEARS OF





Since the first Tenite plastic was sold in 1932, the trade name, Tenite, has come to symbolize the utmost in quality, color and service. *Tenite plastics*—Butyrate, Acetate, and Polyethylene—are produced at the highest quality levels possible. *Tenite colors* are unmatched for brilliance, durability and range. And *Tenite service* is well known throughout the industry for its effective thoroughness.

While 25 years would be only one of many milestones in most industries, in the young and vigorous plastics industry Eastman's quarter-century actually spans the modern era of thermoplastics and injection molding. The medallion shown on the opposite page has been created to mark the occasion of our 25th Anniversary as a producer of thermoplastics, and to commemorate our long association with the plastics industry. We hope this souvenir medallion, which is injection molded of Tenite Butyrate, will remind our many friends of our long experience in their field.

TENITE PLASTICS

1932—Tenite Acetate introduced. The original Tenite plastic, offering a wide range of desirable properties, including toughness, light weight, impact strength, enduring luster and low heat conductivity. Available in a variety of formulations and almost unlimited colors. Typical uses: shoe heels, appliance housings and parts, toys, novelties.

1938—Tenite Butyrate introduced. Extremely tough, high in impact strength, resilient, lightweight, lustrous, weather-resistant, dimensionally stable. Available in a wide variety of formulations and an almost unlimited range of crystal, transparent, translucent, opaque, metallic and variegated colors. Typical uses: steering wheels, business machine keys, tool handles, telephone housings, football helmets, industrial pipe, toys, marine floats.

1954—Tenite Polyethylene introduced. Virtually unbreakable, chemically inert, resistant to water and moisture transmission and to strong acids, excellent insulator. Available in spherical pellets, in natural or wide range of colors and colored concentrates, with or without antioxidant. Typical uses: housewares, toys, packaging film, pipe and tubing, wire and cable covering, coating for paper, film and foil.

EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, **KINGSPORT, TENNESSEE**

TENITE

BUTYRATE · POLYETHYLENE · ACETATE

plastics by Eastman

INDUSTRIAL

BESTWALL®

GYPSUM PLASTERS

SOLD THROUGH

BESTWALL CERTAIN-TEED SALES CORPORATION

120 East Lancaster Avenue
Ardmore, Pa.

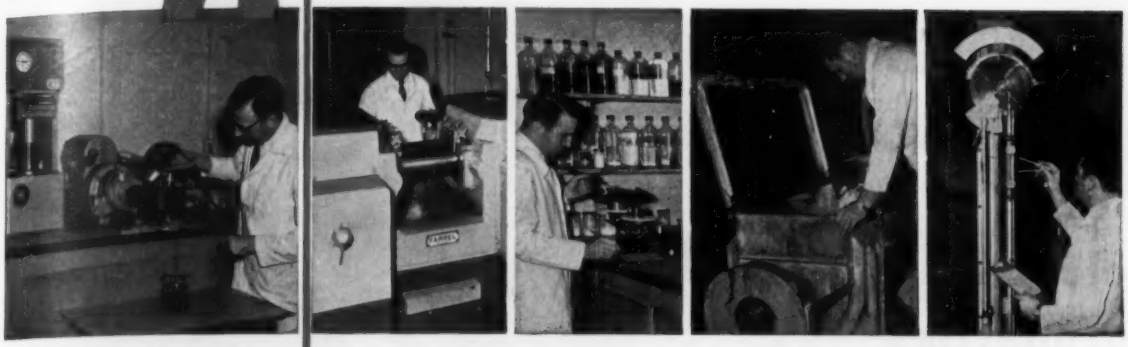
EXPORT DEPARTMENT:
100 East 42nd St., New York 17, N.Y.

CUSTOM MADE PLASTER

Whatever your requirements, Bestwall and its distributors are ready to work closely with you, and to recommend the specific industrial plaster that will improve your product or raise your plant efficiency. Write or call General Office, Ardmore, Pa.

POTTERY PLASTERS **K-56**	For general mold work in potteries as jigger molds, casting molds, and in mold and model work. Also used for casting art objects such as plaques, statues, novelties, etc.	This plaster is especially treated during manufacture to give it unusual surface hardness in the set state, providing long mold life at lower production costs. Compressive strength at pouring consistency (dry cast): 2300 psi.
K-62	An extra fine ground pottery plaster designed to give the best possible results in mold wear. A premium product.	Treated for shock resistance. Powder is white but gives light blue color in slurry and cast. Produces the most durable, strongest cast of any pottery plaster. Compressive strength at pouring consistency (dry cast): 3200 psi minimum.
SUNFLOWER MOLDING PLASTER	Sunflower Molding is used for shop cast ornamental work, statuary, plaques, novelties, terra cotta and Portland cement molds.	Made from high purity rock with lower water requirements than regular gypsum plasters, giving strong casts at pouring consistency.
INDUSTRIAL DENSITE K-6 (High Expansion)	For casts that demand extremely high strength and low water absorption. Perfectly suited for use with mold materials such as wood, plaster, rubber, clay, metal. As a conditioner for ordinary plasters to obtain intermediate strength.	The strongest and hardest pure gypsum plaster available. At pouring consistency, the tensile and compressive strengths and surface hardness of the dry casts are about five times those made of ordinary plaster. Compressive strength at pouring consistency (dry cast): 9000-10,000 psi.
LOW EXPANSION DENSITES **K-12**	For case and block molds, patterns and models where great strength, hardness and wear resistance are desirable in a low-expansion material.	This is the strongest, hardest low-expansion plaster available today. Its amazingly low expansion—.03 to .04%—makes it ideal where accurate dimensions must be maintained. It has a normal period of fluidity and plasticity. May be mixed with ordinary plasters of intermediate strength and expansion. Compressive strength at pouring consistency (dry cast): 6000 to 7000 psi.
K-12-F	For detailed case molds, patterns and models or wherever an extremely fine grind low-expansion plaster is indicated.	Where extreme sharpness of intricate detail combined with unusual surface smoothness is desired, this fine grind version of Densite K-12 is now available. This is the finest grind low-expansion plaster obtainable today. Excellent for production of superior case molds.
K-17	For all types of patterns and molds where dimensional stability, high strength and low heat generation are important such as splash casts over wood models.	A Densite formula of a low setting expansion .04-.05%, high strength up to 10,000 lbs./sq. in. and low heat generation. Dimensionally stable.
K-25	For pattern and model work where plaster has to be rodded to a contour or where shell casts are taken from a master mock-up.	A Densite formula made plastic so that it is easily built up on curved and vertical surfaces. Low setting expansion and high strength.
BREAKAWAY PLASTER	Usable for expendable mandrels that can be readily broken up and removed.	A special gypsum plaster of high water carrying capacity and relatively low strength. Set casts will disintegrate and can be removed with hot water or steam.
CERTROCK	For case molds. Its high fluidity reproduces the finest details, assuring extremely smooth, non-porous surfaces on finished molds.	A high purity gypsum plaster with over twice the tensile and compressive strength of standard plasters, resulting in little breakage. Compressive strength at pouring consistency (dry cast): 4500 psi. (*Note: This plaster cannot be built up or carved.*)

A. Schulman, Inc. answers today's biggest plastic question . . .



Why are so many molding and extruding plants buying

LABORATORY CONTROLLED

processed vinyl and polyethylene?

Because they're saving money. Our processed vinyl and polyethylene DO cost less, but at the same time, precise laboratory control assures a product of the highest quality. Working with modern methods and machines, we are able to fill your raw material orders to EXACT specifications, at definite savings to you. HOW?

We maintain complete laboratory equipment of the very latest type, and a staff of highly skilled technicians checks the quality of vinyl and polyethylene we buy, then keeps a constant watch on our processing. Whether you do molding or extruding, we are in a position to handle your requirements . . . just let us know what product you make and give us your specifications.

There is NO GUESSWORK involved — and it COSTS YOU LESS.

Samples mailed on request.

If you make products like these you can depend on A. Schulman, Inc. laboratory controlled polyethylene and vinyl. **A TRIAL ORDER WILL CONVINCE YOU!**



A. Schulman Inc.

AKRON, OHIO
790 E. Tallmadge
HEmlock 4-4124

BOSTON, MASS.
738 Statler Bldg.
LIberty 2-2717

LOS ANGELES, CALIF.
1127 Wilshire Blvd.
MAdison 9-1493

NEW YORK CITY
460 Park Ave.
MUrray Hill 8-4774

E. ST. LOUIS, ILL.
14th & Converse
BRidge 1-5326

BUFFALO, N.Y.
33 Berkley Place
ELmwood 1751

A. SCHULMAN, INC., LTD.
Ibex House, Minories
LONDON E.C. 3, ENGLAND
Telephone: Royal 4989

A. SCHULMAN (U.S.A.) GmbH
Bodekerstrasse No. 22
HANOVER, GERMANY
Telephone: 2-6212

locked-in
protection
for
electrical
properties



DAPON® resin

superior moisture resistance

Completely protected and locked-in—the excellent electrical properties inherent in cured DAPON resin are protected by the *resistance* of DAPON resin *to moisture in all forms.*

DAPON resin is the *new prepolymer* of diallyl phthalate—a dry white powder with improved properties. It is *easy to handle and store.* Its advent has made possible the use of diallyl phthalate in *all processing methods* for thermosetting resins.

Because the cure of DAPON resin involves addition polymerization, and not condensation, *moisture formation is non-existent* during cure.

Think of an electrical connector with *volume resistivity higher than that of porcelain* with complete protection that guarantees the retention of these properties under the most adverse conditions. This is DAPON resin.

Rid yourself of the moisture problem. Be assured of locked-in initial properties and locked out moisture. *Write now for technical literature containing properties, uses and methods of application for DAPON resin.*

fmc®

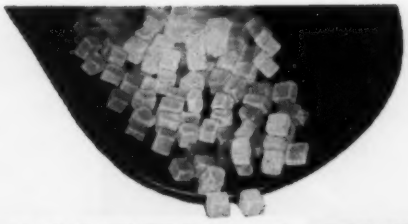
FMC Organic Chemicals Division
Food Machinery and Chemical Corporation
O H I O — A P E X
161 East 42nd Street • New York 17, N. Y.

fmc FOOD MACHINERY AND CHEMICAL CORPORATION®

chemicals

OTHER FMC CHEMICAL DIVISIONS: WESVACO CHLOR-ALKALI Alkalis, Chlorinated Chemicals, Carbon Bisulfide WESTVACO MINERAL PRODUCTS Phosphates, Barium and Magnesium Chemicals • BECCO CHEMICAL Peroxygen Chemicals • NIAGARA CHEMICAL Insecticides, Fungicides and Industrial Sulphur • FAIRFIELD CHEMICAL Pesticide Compounds

PLASTICIZERS OHIO APEX fmc®



WHERE POLYETHYLENE IS USED...

A-C® Polyethylene ..... delivers • QUALITY! • SAVINGS! • SPEED!

...for INJECTION MOLDING

Molders who use A-C Polyethylene in their operation gain distinct competitive advantages. Controlled gloss, better color dispersion, and the ability to run larger, more intricate parts are the definite product advantages. Faster cycles, positive mold release, lower operating temperatures and less overall machine maintainance, are the profit-making features contributed by the controlled flow possible with A-C Polyethylene. By simply changing the percentages of A-C Polyethylene, you can greatly reduce the variety of polyethylene grades required in inventory and still have control of resin flow characteristics to meet all kinds of molding problems.

...for FILMS, PLAIN AND COLORED

In the extrusion of Polyethylene films, adding A-C Polyethylene gives faster rates, lower extrusion temperatures, lessens machine stress, and makes gauge control easier.

For colored film, A-C Polyethylene is invaluable for even, streakless pigment dispersion. Colored films using A-C Polyethylene dispersed color pigments are strikingly brilliant and uniform.

...for SLUSH MOLDING

A-C Polyethylene offers an entirely new material for slush molding. With this new polymer you can use less expensive molds, get faithful mold reproduction with fine detail and the finished part has a warm, "life-like" feel. Finishes from dull to high gloss are possible.

...for COATINGS

Coatings containing A-C Polyethylene give a hard, scuff-resistant, glossy surface. Excellent low temperature flexibility and the elimination of blocking problems are added attractions to the converter.

Bread and frozen food wraps are glossy and scuff-resistant.

Shipping cartons are grease resistant and need no liner to protect contents from fibre scratchings.

Butter and frozen food cartons, and bakery cartons are grease resistant and feed as single units to automatic packaging machinery.

POLYETHYLENE FOR POLYETHYLENE!!

A-C Polyethylene is a low molecular weight polymer of ethylene with a high melting point but a low melt viscosity. You can add A-C Polyethylene to other polyethylene resins with complete confidence in their compatibility. The improvements in product quality, the operational savings, and the production advantages derived from varying percentages of A-C Polyethylene, give you a flexibility in raw material which is unique in plastics operation. No special equipment is required to take advantage of A-C Polyethylene.

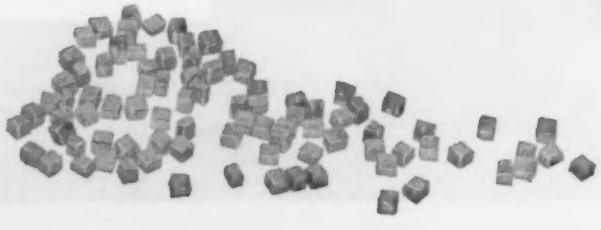
Two Forms — Range of Grades

A-C Polyethylene is available in two forms to meet a variety of production methods. For ease of handling the uniform cubes, as illustrated here, meet most requirements. A finely powdered form, called "atomized," is especially suited for certain more difficult blending operations. You can obtain either a hot melt polyethylene or water emulsifiable grade of this unique material depending upon the specific needs of your operation.

Write today for complete information. We will be glad to demonstrate the proven advantages of using A-C Polyethylene.

SEMET-SOLVAY PETROCHEMICAL DIVISION
Allied Chemical & Dye Corporation
Room 520-W
40 Rector Street, New York 6, N. Y.

Allied Chemical




A world of applications —
fitted to your product property requirements
Plenco
PHENOLIC MOLDING COMPOUNDS
Plenco engineering and chemical research is a continuing factor in the development of new uses for phenolics in the manufacture of high quality products. We welcome the opportunity to show you how many of the country's leading molders have solved their most exacting product and production problems . . . through a wide range of quality-tested Plenco compounds and resins.
NEW FORMULATION!
Plenco 476
Semi-impact molding compound with improved water resistance and dimensional stability.
After 120 hours of continuous boiling in a 3% commercial detergent water solution, Plenco 476 has a total moisture gain of less than 2%. Dimensional change less than 0.5%. An additional 240 hours of continuous exposure to boiling produced no further gain in weight or dimensional change. Applications of Plenco 476 include vaporizers, dishwasher and washing machine components, blowers, humidifiers, water pump impellers, etc.
Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.
PLASTICS ENGINEERING COMPANY
SHEBOYGAN, WISCONSIN
PLENCO PHENOLICS
FOR BETTER PLASTIC PRODUCTS

Advertisers' Index

FOAMED PLASTICS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 334.

CUSTOM MOLDERS, FOAM PLASTICS

Ambassador Plastics & Mfg. Corp. 362

FOAMING AGENTS

du Pont de Nemours, E. I. & Co. (Inc.), Explosives Dept. 361

ACCESSORY EQUIPMENT

DeVilbiss Company, The 362

Foamed Plastics

IN THIS SECTION

Foamed Vinyls 334
Foamed Polyurethanes 339
Cellular Cellulose Acetate 343
Expanded Polystyrene 344
Expandable Polystyrene ... 347
Cellular Polyethylene 350
Foamed Phenolic 352
Foamed Silicones 356
Foamed Epoxies 358

In the light of recent developments in the field, foamed plastics now stand out as one of the most exciting and fastest growing segments of the plastics industry. As a guide to the activities in this complex area, this section is devoted to a complete review of all commercially available rigid and flexible foams.

FOAMED VINYLS

Applications
(Open Cell)

BY HENRY E. ALLEN*

Flexible, open-cell vinyl foam is by far the most important and largest-volume type of expanded or cellular vinyl material on the market today. All open-cell, flexible vinyl foam (OFVF) is based on variations and modifications of the well-known and widely-used vinyl plastisol technology. The versatility of OFVF is possible because, with the plastisol technique, the basic vinyl resin characteristics can be modified or varied by mixing the resin with a wide range and combination of plasticizers. Important variations and unusual versatility may be obtained by varying both the total plasticizer-to-total resin ratio and the ingredients of the plasticizer system. Further property variations, particularly of density, may be obtained without changing the formulation by merely varying foaming process conditions.

Cushioning characteristics

The most important functional property of any open-cell flexible foam is its comfort as a cushioning material and its durability. In determining the value of a cushioning material, the consuming public seems to like a combination of softness and firmness, plus resilience and comeback without bounciness. Engineers, thus far, have been unable to come up with wholly adequate measurements of these attributes. The flexible vinyl foam committee of the S.P.I. Cellular Plastics Div. has approved a tentative specification and test procedure for measuring compression resistance or indentation load deflection, but these single point deflection readings (25%) provide only a measure of hardness, and not a means of measuring or of assaying the actual feel or resilience that the user wants. The important fact is, however, that through careful formulation (which includes resins, plasticizers, stabilizers, pigments, and surface active agents) vinyl foam can provide the desired characteristics for both the comparatively soft and springy cushioning required for comfort in home furniture, and the firmer and greater energy-absorbing type of cushioning called for in transportation seating where road and roadbed conditions significantly affect comfort.

The most important service requirement of any open-cell flexible foam cushion is that it maintain its original dimensional and load-carrying ability during the lifetime of the product of which it is a component. A flexible foam cushion that permanently loses thickness under service conditions

* Vice President, Elastomer Chemical Corp., 212 Wright St., Newark 5, N. J.

Recent Developments and References were prepared by the editors.

Foamed polyethylene (*Agilene-*, American Agile Corp.), available in such semifinished molded components as rings, blocks, rods, and sheet, may be used in heat and electrical insulation, soundproofing applications, and the like. The foam has a specific gravity of 0.46, is unicellular, light in weight, and extremely buoyant. It has a tensile strength of 500 to 600 p.s.i. and good compressibility.

Silicone foam rubber (*Cohrfoam,* The Connecticut Hard Rubber Co.) is light in weight and remains soft and resilient over a temperature range of —100 to 480° F. It can be molded into complex shapes and has already found application as airframe seals where no other material has been found successful.

Continuous urea-foam equipment (W. H. Kreidl) produces about 270 cu. ft./hr. of urea foam of a density of 2½ to 4 lb./cu. foot. One unit produces granules for insulating purposes. Another type makes bats or strips. These strips are still appreciably thermoplastic as they come out of the dryer, and are warm-pressed to the desired shapes and surfaced with plastic sheeting. They are used as insulating mats for the building trade and for appliances, as well as for packaging of breakable and friable goods.

Sponge plastisols (Stanley Chemical Co.), made from vinyl resins and chemical blowing agents, may be of open- or closed-cell construction, atmospherically or pressure blown, with variations in toughness, compression resistance, and flame resistance. There are formulations for knifing, roller coating, hot and cold dipping, slush molding, and casting and pressure molding.

A new molding-in-place technique has been developed (The Dow Chemical Co.) for expandable polystyrene. This technique utilizes exothermic heat developed from the cure of thermosetting resins. Structural foams obtained by this technique are characterized by excellent dimensional stability, low water absorption, good low-temperature insulating properties, and the ability to bond to many different surfaces according to the developer.

Pipe insulation (Mundet Cork Co.), molded from expandable polystyrene beads, for an air-conditioning system at Idlewild Airport, is probably the largest foamed polystyrene bead application to date. It involves about 20,000 ft. of pipe; the thicknesses of the insulation sections are 1, 2, and 3 in., depending upon the need.

Expandable polystyrene beads (*Dylite,* Koppers Co., Inc.) are used to produce 24-in. wide continuous slabs up to any practical length (Dyfoam Corp.). The planks are sold for insulation in cold storage warehouses, refrigerated trucks and railroad cars, sectional refrigerators, and building or residential construction.

Prefoamed blocks of epoxy resin (*DuRafoam,* D & R Pilot Plants, Inc.) are now available in sizes up to 1 by 2 by 6 ft. and in densities from 5 to 20 lb./cu. foot. The foams are easily machined and have compressive strengths of from 50 p.s.i. at the lower densities to about 1000 p.s.i. at the higher densities. Recommended uses are for check fixtures, templets, and models.

Flexible polyurethane foam with densities of 3 to 4 lb./cu. ft. can be produced at room temperatures in a matter of minutes using a two-component liquid system of polyesters and isocyanates. The manufacturer (Dayton Rubber Co.) suggests the use of this material for in-plant foaming of shoulder pads, toys, insulating materials for clothing, etc. A scale, mixing vessels, molds, and an exhaust fan are said to be the only necessary equipment.

A foamed, free machining, high-temperature epoxy resin (*Eccostock R 20,* Emerson & Cuming, Inc.) is completely unicellular and has an operating temperature range from —100 to 350° F. The specific gravity of this material is 0.61; the dielectric strength (volts/mil), 350; and the volume resistivity (ohm-cm.[3]), $10.^{14}$

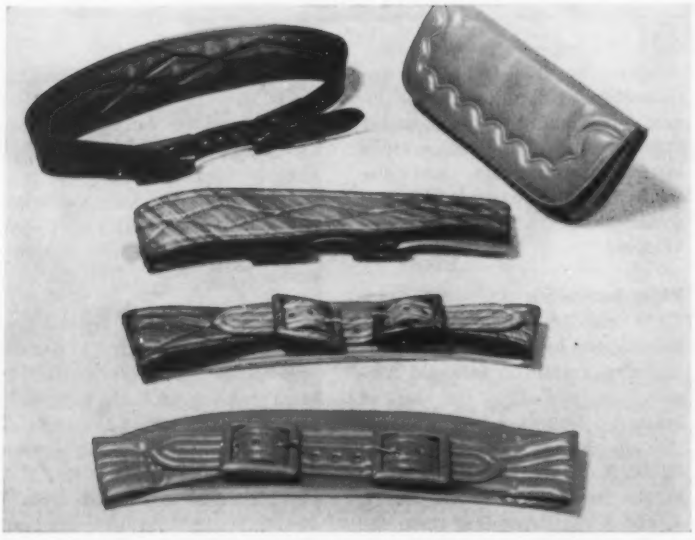
A flexible urethane foam (Isocyanate Products, Inc.) with a load deflection curve similar to foam rubber and an extremely low compression set is suggested for use in the comfort seating field by the manufacturer. This foam can be produced from a two-component liquid system and can be either hand or machine mixed.

A polyester developed for the production of urethane foams (*Witco Fomrez No. 50,* Witco Chem. Co.) has both a narrow hydroxyl number and viscosity range and a uniformly low moisture content. It produces reproducible, uniform urethane foams.

New polyethers (*Pluronic* and *Tetronic,* Wyandotte Chemicals Corp.), based on ethylene and propylene oxide, are available for reaction with isocyanates to make urethane foams. They are lower in cost than other polyethers and also cheaper than adipic-type polyesters.

Foam made from polyether resin (*Teracol 30,* Du Pont) has more softness, greater freeze resistance, higher resiliency, and greater load-carrying capacity than polyester urethane foam.

A polyether-based resin and catalyst system has been developed (Chase Chemical Corp., Pittsburgh, Pa.) to produce low-density flexible polyurethane foams. The system produces foams that set and are tack-free 5 min. after pouring and cure in 10 min. without the use of heat or pressure. The company states that both resin and catalyst are stable and have good shelf life and can be used without modification as they are shipped to the fabricator.



Fashionable belts and handbags are created by electronically heat-sealing sheets of vinyl foam to vinyl sheeting. Heat-sealing is also used to give the finished products a three-dimensional quilted effect. (Photo, Elastomer Chemical)

is said to have taken a permanent set. Similarly, a cushion that becomes softer after constant flexing is said to have suffered a loss of compression or load-carrying ability. On the basis of actual service tests, OFVF has been found to be outstanding on both these counts. Long-term service tests of OFVF indicate that it takes less permanent set than foam rubber. (However, available test methods, which unfortunately are not adequate for evaluating a thermoplastic material, indicate vinyl foam to be somewhat inferior in this regard.) OFVF, since it is thermoplastic, also exhibits temporary differences in hardness or load-carrying under varying temperature conditions, but formulations can be adjusted so that comparatively flat temperature-hardness curves may be obtained, making the differences in hardness noticeable only under conditions of extreme temperature variation.

Another important property of OFVF is the ease with which it can be reshaped and, if desired, bonded to other materials by using various electronic heat-sealing, embossing, printing, and hot-wire cutting techniques.

All vinyl foam must be properly fused in order to secure optimum properties. Once properly fused, however, its over-all aging and strength characteristics are excellent. Vinyl foam will not oxidize, dry out, or harden. It is not subject to hydrolysis even under moisture conditions of 100% humidity for extensive periods at elevated temperatures. It is highly resistant to most inorganic acids, alkalies, oils, greases, aliphatic hydrocarbons, and alcohols. Of major importance for many nonseating consumer applications, where one or more surfaces of the foam are exposed, is vinyl foam's color fastness. It can be made in fade-proof white or colors.

OFVF is almost as versatile from a fabricating standpoint as it is from a compounding standpoint. Five different techniques for the production of OFVF products are already a commercial reality and several other techniques are now in the pilot-plant or experimental stage. Included in the first group of current techniques and fields of application are: 1) cored and contoured molded cushions; 2) molded products with integral skins; 3) slab or sheet applications in transportation seating and furniture; 4) electronically heat-sealed vinyl foam slab for a variety of consumer products; and 5) electronically heat-sealed laminated structures for furniture upholstery. Techniques that are under consideration, but not yet commercialized, include extrusion, direct application of foam as a backing to other materials, and adhesive or heat-type laminations.

Jump seat pads for taxicabs are molded of vinyl foam so that each piece has its own skin integral with the foam beneath it. (Photo, Elastomer)



End-uses

Cored and contoured molded cushions: This is the most familiar and well-established type of foam cushioning product. Such cushions are made in lightweight aluminum molds. The internal surfaces of these molds are shaped to provide the necessary contour and edge radii. In addition, the weight-resilience relationship can be effectively controlled by a multiplicity of core holes which are formed by hollow pins attached to the mold cover plate.

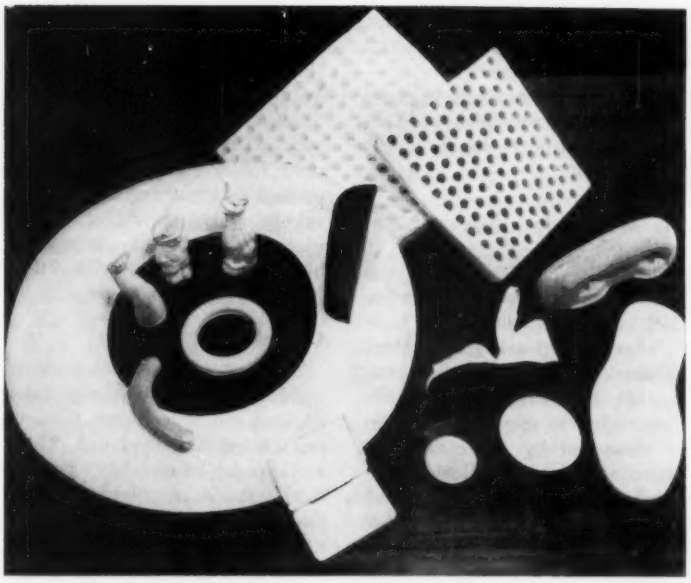
Molded products with integral skins: The molds for products of this type can be contoured and cored as above, but also have one additional important characteristic. A design is cast or formed into one or more of the interior mold surfaces. Then, by spraying, slush molding, or brushing an unexpanded plastisol against the preheated mold surface, an unexpanded skin is formed with the desired surface design. Thereafter, the foam is flowed or sprayed into the mold, and after the mold cover (which, if prime-coated, adheres to the foam and serves as a mounting plate) is positioned, the entire assembly is cured and subsequently cooled and stripped as a unit. The resulting product has its own skin which is not only integral with

foam beneath it, but which also has the desired surface pattern and color. Thus, the laborious hand upholstery operation can be eliminated.

Slab or sheet applications in transportation seating and furniture: Where maximum cushioning properties are desired for cushioning furniture and transportation seating, and where design does not permit use of thick foam cushions, vinyl foam has been found to be particularly effective. In addition to the resilience and comfort requirement, vinyl foam in this case meets the additional important requirement of fire resistance.

Electronically heat-sealed products: By using electronic-sealing instead of the previously required molding, die-cutting, and sewing techniques, OFVF can be economically adapted to a variety of consumer products. OFVF is furnished to the heat-sealer in slab or roll sheet form in any desired thickness and in a wide variety of attractive colors. The only fixed investment involved is a properly shielded electronic heat-sealing press and an air compressor or air line connection. The dies used in these machines are extremely inexpensive, ranging from as low as $50 to several hundred dollars, depending upon their size, number of cavities, and complexity. The combination of machine, dies, jigs, and material can be used to form many special shapes such as sponges, brushes, sun visors, arm rests, and many other products and components. Quite frequently the technique is used to make a product consisting of vinyl foam which is sealed to vinyl film or fabrics on either one or both surfaces. "Tear-seal" dies may also be used to obviate subsequent die-cutting or hand-trimming operations.

Electronically heat-sealed laminated structures: While small semi-automatic presses are adequate for fabricating the products discussed above, larger capacity and more fully automated quilting machines must be used for turning out full widths and rolls of sandwich-type laminated materials. The most successful product of this type is composed of a top surface of vinyl-coated fabric, an inner cushioning layer of OFVF in the desired thickness, and a backup layer of a heavy duck fabric. This construction has been widely used in the furniture and automotive upholstery fields. Another combination consists of a satin-surface fabric layer and a vinyl foam backing.



Typical applications for the various types of closed-cell vinyl foams include flotation equipment (buoys, floats, life belts, etc.), outer shoe soles, slippers, and molded and contoured seat cushions. (Photo, Foam King)

(Closed Cell)

BY H. DASH*

Closed-cell vinyl foam is available in both rigid and flexible form and is produced by either of two processes: high-pressure or atmospheric blowing.

In the high-pressure method, a plastisol containing a chemical blowing agent is poured into a steel mold flush with the top edge. The mold is covered with a top plate and gasketed with soft aluminum sheeting. External pressure on the top plate is maintained by hydraulic pressure. Internal pressures developed depend on cavity volume and on the concentration of blowing agent in the plastisol. The temperature of the mold is rapidly brought to the fusion point of the plastisol. At this temperature, the gas is also released from the blowing agent. Because of the high pressures developed, the released gas remains dissolved or dispersed in the fused plastic mass. The latter is cooled in the mold prior to removal. Expansion is achieved by reheating (at about 200° F.) the fused plastic until equilibrium with atmospheric pressure is reached.

The atmospheric-pressure method makes it possible for the material to be produced as slab stock of unlimited size on a continuous conveyor system and without the need for pressurized equipment. In the atmospherically blown method, a vinyl plastisol containing a chemical blowing agent is also used. However, in this method, the plastic mass is fully expanded prior to complete fusion. In thick sections (over 2 in.), optimum internal curing is accomplished by dielectric heating.

Applications of closed-cell vinyl foam include flotation equipment (buoys, floats, life belts, etc.), Arctic clothing, outer shoe soles, thermal and acoustical insulation, gasketing, etc. Outstanding properties of closed-cell vinyl foams are low water absorption, good aging and weathering characteristics, and low thermal conductivity coefficient. Other properties: dimensional stability—up to 2½%

* Technical Director, Foam King, Inc., 1816 Boston Rd., New York 60, N. Y.

linear change after heating 24 hr. at 158° F.; dielectric constant—1.2 at 10^6 cycles; dissipation factor—0.2 at 10^6 cycles; resistant to many acids, alkalies, and alcohols, moderately resistant to aromatic chemicals.

Techniques

BY PETER S. WEILL*

Expanded polyvinyl chloride falls into two classifications: unicellular (closed-cells) and interconnecting (open-cells). The percentage of closed or open cells present in the foam product can be measured by immersing the expanded polyvinyl chloride material in water under vacuum and determining the amount of water that is absorbed (ASTM D-1056-54T).

Several techniques are used to produce expanded vinyls. The first involves the use of chemical blowing agents. The products in this case are generally called *sponges*. Both open-cell and closed-cell expanded vinyl can be produced by this method. The second technique consists of the incorporation of an inert gas in a plastisol by dispersion or solution, and the product is called *foam*.

The more important blowing agents used in expanded vinyl processes are nitrogen-producing compounds. The mechanism of the release of gas is generally one of chemical decomposition caused by heat, which evolves gas and forms thousands of tiny bubbles in the vinyl. Two main processes are used for the production of expanded vinyls with blowing agents: closed blow (for unicellular products) and atmospheric blow (for products with interconnecting-cell structure).

* Marvinol Development Engineer, Naugatuck Chemical, Div., United States Rubber Co., Naugatuck, Conn.

Closed blow

The first process uses a closed mold in which relatively thick sections of unicellular (closed-cell) vinyl are produced. These sections can be sliced to whatever thickness is required. In the closed mold technique, the molded articles retain the details and proportions of the mold, even though the expansion is completed outside the mold.

Extreme caution should be taken when blowing in a closed mold since very high pressures can be developed when the blowing agent decomposes. The mold should be made from sturdily constructed metal in order to withstand the high pressure developed by the blowing agent. A safety factor, covering the possibility of added pressure from vinyl breakdown through an improperly stabilized system, must also be taken into account when using this technique.

The recipe used in preparing closed-cell vinyl sponge varies to some degree, depending upon end-use requirements. In general the recipes consist of vinyl resin, plasticizers, a chemical blowing agent, and stabilizers. A starting point recipe is:

Marvinol VR-10	100.0
Di-2-ethylhexyl phthalate (DOP)	130.0
Barium-cadmium stabilizer (Advance BC-105)	3.5
Celogen	12.5
Celogen AZ	12.5
	258.5

Densities of 4 to 6 lb./cu. ft. are obtained with this formulation. A formulation such as shown above may be prepared with all the ingredients ground on a paint mill. The mold is then filled with the paste and clamped in a steam-heated press. A typical cycle for a 1-in. thick frame is 15 to 25 min. at 320 to 350° F. This is an average cycle and will vary with the formulation. For a ½-in. frame, the same temperature is used but the cycle is cut approximately in half. Mold heat capacities and the method of heating will, of course, determine the variation in the fusion cycle. In general, however, it is advisable to obtain uniform fusion throughout the plastic matrix before decomposition of the blowing agent takes place.

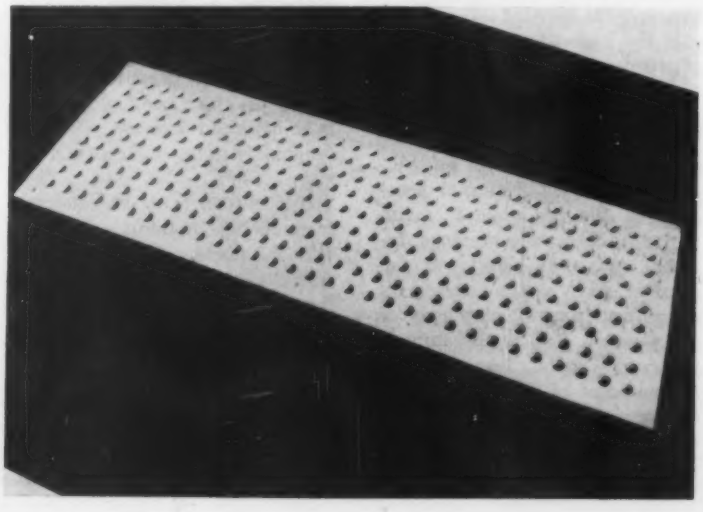
Following the fusion and blowing steps, the closed mold should be cooled. The center of the plastic mass should be well below 200° F. before the mold is opened; otherwise, the stock will be so soft that there is a chance it will rupture.

When the piece is released from the mold, it will be partially expanded. It may then be brought to its maximum expanded size by heating for approximately 1 hr. at 215 to 220° F. in an air-circulating oven. Annealing, which is generally beneficial to the dimensional stability of the finished expanded piece, may be done by subjecting the piece to temperatures of 130 to 150° F. for several hours.

Atmospheric blow

The second method of producing expanded vinyl by the use of blowing agents is called the "free

Developments in molding techniques have made it possible to turn out contoured, cored subway seat cushions of open-cell vinyl foam. (Photo, Elastomer)



blow." This method involves casting on an open mold or coating a suitable web with vinyl dispersion in which a blowing agent has been mixed. The vinyl material is then fused at oven temperatures of 330 to 400° F. and allowed to expand at atmospheric pressure. Free blow expanded vinyl generally contains some interconnecting cells, although 100% unicellular foams are possible.

Plastisol for this method may also be stirred in or ground on a paint mill, but the formulation is slightly altered from the one offered in the closed blow technique. A solvating type of plasticizer is generally necessary to insure fast fusion. The blowing agent content is usually much less than the amount used in the closed blow method. A starting point recipe would be as follows:

Marvinol VR-50 or VR-51	100.0
Diisooctyl phthalate	100.0
Diethylene glycol dibenzoate	20.0
Dythal	3.0
Celogen AZ	0.5— 1.5
	223.5—224.5

Densities of 15 to 20 lb./cu. ft. are normally obtained with this formulation. Open-cell chemical blown vinyl is used extensively as thermal insulation in slush molded plastisol footwear.

Mechanical blow

The second major technique of expanding vinyl is based on the incorporation of an inert gas in a plastisol by mechanical action or by solution in the plasticizer. This product is called vinyl *foam*. A process patented by the Elastomer Chemical Corp. utilizes this technique for making interconnecting-cell vinyl foam. With this process, a wide range of cell structure, resilience, low-temperature flexibility, and load-carrying properties can be obtained. In the Elastomer process the liquid vinyl plastisol is thoroughly mixed with an inert gas, such as carbon dioxide, or nitrogen, at a pressure of 300 to 500 p.s.i. A means of cooling is provided during the agitation in order to increase the solubility of the inert gas in the plastisol. The foamed plastisol, the appearance of which is like whipped cream, is released through a nozzle into a mold, or deposited on a moving forming belt, and leveled by a doctor blade before passing through a dielectric heating unit where it is gelled and fused.

A typical rate of production that has been quoted for vinyl foam slab, 2 in. thick, is 400 lb./hr. on a conveyer speed of 1½ ft./minute. The finished foam is cut and split to the desired size of stock and wound on rollers for storage. By the use of the Elastomer method, continuous production of open-cell vinyl foam, in the density range of 5 to 7 lb./cu. ft., is commercially practical. Sheet stock is now available 60 in. wide up to 4 in. thick.

The Fay Foamer Process, developed by Dennis Chemical Co., utilizes the solubility of the CO_2 gas and incorporates it in the plastisol in a counter-current absorption column. Plastisol is pumped into the top of the tower and allowed to trickle down over packing. CO_2 is introduced into the tower under the packing and moves upward until dissolved in the plastisol. The pressure (below 100 p.s.i.) maintained in the column controls the density of the vinyl foam. For low-density vinyl foam production, a two-stage absorption unit is recommended. The foamed plastisol is then applied and fused in the same manner as described in the previous paragraph.

Mechanically blown vinyl foam can readily be compounded to fire retardancy. The open-cell structure of vinyl foam "breathes" and therefore has found considerable use in the cushioning field.

FOAMED POLYURETHANES

Applications

BY W. W. MARSHALL*

The polyurethane foams are cellular materials prepared by the reaction of polyisocyanates, polyester or polyether resins, and water. The significant feature of this system is the reaction of the polyisocyanate with water to liberate carbon dioxide while simultaneously polymerizing and cross-linking the resin to entrap the liberated carbon dioxide. The density of the foams is therefore controlled by the amount of water and excess polyisocyanate used in the formulation.

The urethane foams can be foamed in place and are self-cured by the exothermic heat generated in the foaming reaction. They can be formulated to have a wide range of physical properties, e.g., densities ranging from 1 to 40 lb./cu. ft., and can be made flame-resistant. The three general foam classifications are: flexible, semirigid, and rigid. Each type is produced by a specific resin or mixture of resins with the polyisocyanate.

Raw materials

Due to the economics involved, tolylene diisocyanate is most often used in production of foams. Three types are available commercially (pure 2,4-tolylene di-

* Technical Service Rep., Mobay Chemical Co., 1900 S. 2 St., St. Louis 4, Mo.

TABLE I: Typical saturated polyester used in production of polyurethane foam

Polyester degree of branching	*Approx. hydroxyl No.*	*Approx. acid No.*	*Approx. viscosity @ 70° C.*	*Principal foam application*
			cp.	
High	440	2	4000	Rigid
High	300	3	3000	Rigid
Moderate	215	3	800	Rigid to semirigid
Moderate	165	3	400	Semirigid
Linear	60	1	1000	Flexible
Linear	45	1	700	Flexible

TABLE II: Typical physical properties of flexible urethane foams

	Polyester types			*Polyether types*
Foam density, lb./cu. ft. ±0.2	*1.5*	*2.0*	*3.0*	*2-2.5*
Mechanical properties:				
Tensile strength @ 77°F., p.s.i.	20	25	30	15
Tensile elongation @ 77°F., %	175	250	300	200
Tear strength @ 77°F. (angle method), lb./in.	4.5	5	5	4
Indentation strength (25% indent.), lb./50 in.²	30-60	30-60	45-70	10-25
Compression set @ 158°F., % (based on original thickness)	<15	<10	<7	<10
Compression deflection at:				
10%, p.s.i.	0.6	0.6	0.6	0.1
25%, p.s.i.	0.7	0.6	0.65	0.3
50%, p.s.i.	0.85	0.8	0.85	0.6
70%, p.s.i.	1.3	1.8	2.0	1.2
Miscellaneous data:				
Thermal conductivity, B.t.u./hr./ft.²/°F./in.				ca. 0.25
Dielectric constant @ 68°F. & 1000 cy.				0.13
Power factor @ 68°F. & 1000 cy.				0.008
Volume resistivity @ 68°F.				6 x 10

isocyanate, the 80/20 ratio of 2,4 and 2,6 isomers, and the 65/35 ratio of isomers), of which one or more of the isomer combinations can be used in production of foam. However, the least expensive 80/20 isomer ratio is used most often.

A variety of compounds containing two or more active hydrogen groups, e.g., hydroxyl and carboxyl groups, may be reacted with the diisocyanate to produce foams. Polyesters of moderate molecular weight (1000 to 2500), which terminate principally in hydroxyl groups, are most widely used on a commercial scale. The polyesters vary in degree of branching, with the linear polyesters used for flexible foam and highly branched polyesters used in rigid foams. Several commercial polyesters are listed in Table I, p. 339, relating the polyester to the type foam produced.

In addition to the polyesters, a number of other polyfunctional materials, such as castor oils, glycols, drying oils, and polyethers, have been used to prepare foam. Most promising of these are the polyethers which have been used to prepare flexible foams with excellent properties.

Tertiary amines are most often used to catalyze and control the reaction rates. Typical catalysts are N-methyl-, N-ethyl-, and N-coco-morpholine, as well as triethyl-dimethylcyclohexyl [illegible] diethylethanolamine. Emulsifiers are often used in the formulations to assist in dispersing the reactants and water (which acts as the blowing agent) in the mixing operation.

TABLE III: General physical properties of rigid polyurethane foams

Density, lb./cu. ft. ±0.2	*2*	*3*	*6*	*9*	*12*
Mechanical properties:					
Comp. yield strength @ 77°F., p.s.i.	15	45	150	275	425
Tensile strength @ 77°F., p.s.i.	15	50	140	225	310
Impact strength @ 77°F., in.-lb./in.²	0.6	1.1	1.7	2.8	4.0
Thermal properties:					
Thermal conductivity @ 70°F., B.t.u./hr./ft.²/°F./in.	0.25				
Miscellaneous properties:					
Water absorption, % by volume	2.25	2.0	1.75	1.45	1.1
Electrical properties:					
Power factor @ 68°F. & 1000 cy.				0.006	
Dielectric constant @ 68°F. & 1000 cy.				1.2	
Volume resistivity @ 1000, & 120°F., ohm-cm.				10^{15}	

Flexible foam

These foams have a predominantly open-cell structure and are available in density ranges from 1.5 to 6.0 lb./cu. foot. The unique physical and chemical properties (Table II, left), such as high strength/density ratios, high abrasion resistance, resistance to oxidation, oil, mildew, fungi, and vermin, have afforded it acceptance in a variety of applications. The foams are odorless, nonallergic, and may be washed or dry cleaned. They can be sewn or fabricated with available machinery and are made in a wide range of colors.

Advances in this field have been made in the development of polyether foams. These are softer and more resilient, and have greater resistance to accelerated hydrolysis conditions and better moldability than the conventional polyester-type foam.

Generally, the flexible foams are finding increasingly wide usage as clothing innerliners, shoulder pads, carpet underlay, cushions (furniture and airplanes), mattresses, topper pads, acoustical tile, packaging, paint and wax applicators, and many other applications.

Rigid foams

Available in a density range of 1 to 40 lb./cu. ft., these foams are mostly used in applications that utilize their ability to be foamed in place along with their structural and adhesive strength, as well as high impact and vibration resistance. Because of the unicellular structure, rigid foams are excellent thermal insulators, in addition to having high oil and solvent resistance and low water permeability. The maximum use temperature is high and depends entirely on the specific end-use requirements. (See Table III, left.)

Materials for producing rigid foams are also marketed as a two-component package system which enables fabricators to foam in

place by simply mixing the two prepared components and pouring them into the form or mold to be filled. This system is especially useful for filling small voids where full-scale machinery is not warranted.

A growing number of commercial uses have been found for the rigid foams in construction materials, airplane wings and ailerons, vacuum bottles and jugs, radar domes, automobile heater housings, railroad refrigerator cars, and refrigerator trucks.

Semirigid foams

Because of their high impact-absorption properties, these foams are used in the production of automobile crash pads, arm rests, and visors. The crash pads are made by fitting a vacuum formed polyvinyl skin into a mold and then pouring the urethane foam mixture into the cavity. Other applications are in shoe innersoles and athletic padding.

Techniques

BY HARRY GERSTIN*

During 1956, production of polyurethane foams—both rigid and flexible types—soared to an estimated 30,000,000 pounds. Responsible for this amazing increase has been the development and perfection of not only the basic chemical components, but of mass production techniques and machinery as well. With these major hurdles out of the way, almost unlimited vistas of application have opened up. By 1960, it is estimated that some 75,000,000 lb. of the foam may be produced.

Types of foams

As a prerequisite to the understanding of production techniques, it might be well first to review the varieties of polyurethane foaming materials available to manufacturers.

Polyurethane foams are produced in two basic types—flexible and rigid. They are available in densities ranging from 1.5 lb./cu. ft. to more than 70 lb./cu. foot. Cell structure diameter varies from microscopic to about ½ inch. They adhere strongly to any surface free from wax or oils. More stable physical properties are achieved with heat curing.

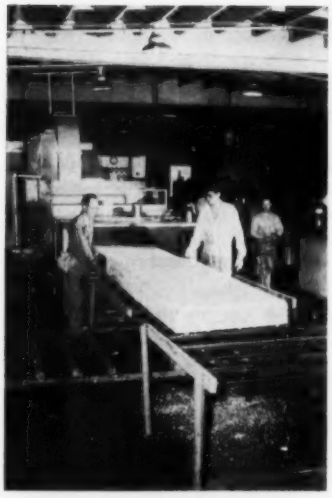
In addition to the obvious differences in rigidity, rigid polyurethane differs from the flexible type in the manner of manufacture. The rigid type is foamed in place simply by mixing two liquids together, then pouring the mixture into a mold at about the time foaming action begins. The rigid type is seldom foamed into slabs and then fabricated—the method by which the bulk of flexible polyurethanes are made.

Mixing of the flexible type involves a far more complicated technique. Depending upon the formulations, temperature, mixing speeds, and other factors involved, flexible polyurethane can be combined to create structures with light cell walls and large cell diameter, heavy cell walls and large cell diameter, light cell walls and small cell diameter, and many other variations. Truck seating may require one special set of physical characteristics, while vibration-damping pads may require an entirely different set.

Factors in production

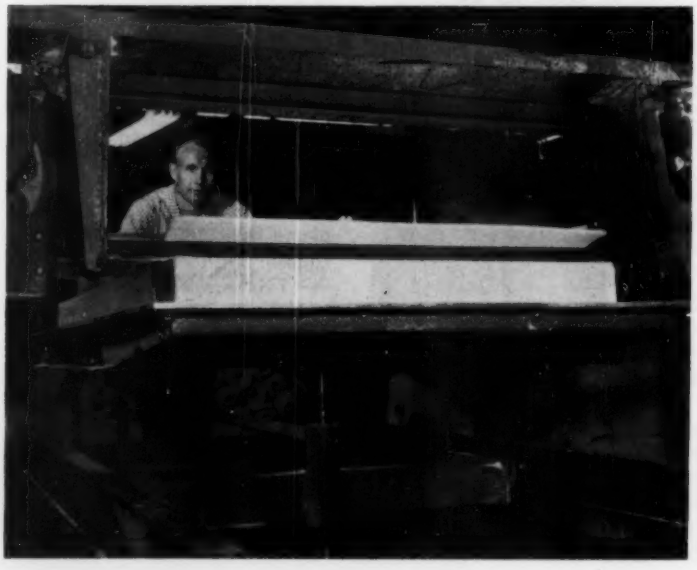
Before any production is attempted, the requirements of the application must be studied and the production process adjusted accordingly. Of course, there are certain standard formulations that may fit a wide variety of applications, but when mass production of the material is planned for a specific use, efficiency and economy call for a thorough study of the requirements.

Although the physical properties of polyurethane are depend-



Slab of flexible polyurethane foam emerges continuously from mouth of automatic foaming unit. (Photo, American Latex)

Band saw is all that is needed to cut polyurethane foam to thicknesses as fine as 1/16 inch. In thicknesses of ⅛ in., polyurethane foam has same insulating properties as ½ in. of cotton and wool felt. (Photo, American Latex)



* Vice President in Charge, Plastics Div., American Latex Products Corp., 3341 W. El Segundo Blvd., Hawthorne, Calif.

ent primarily on the chemical compounds, the production man is equally concerned with their mechanical combination. This includes chemical proportions, mixing rates and techniques, temperature control, mold configuration, and similar factors. Each of these is not only highly critical in itself, but has an extremely delicate relationship with the others. Thus, to produce competitively priced material, production personnel must fully understand both the chemical and mechanical processes involved.

Controlling reactions

Basically, polyurethane is formed by the reaction of a diisocyanate and polyfunctional reactive hydrogen compounds.

Key to production of rigid polyurethane foam is the formation of the CO_2 which creates the foam. Carbon dioxide must be liberated in a linear manner and at such a rate that the gas is entrapped by the matrix of the material as it commences to gel, thus producing a unicellular structure. If the rate is too fast, the material will not be able to support itself, CO_2 will escape, and the foam will collapse.

To produce flexible polyurethane, gelation is regulated so that the gas is permitted to break through the cell walls at the instant when the walls have become self-supporting, but not yet able to prevent the passage of CO_2.

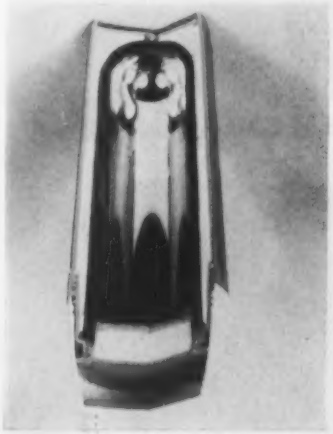
In the mass production of flexible polyurethane these considerations are achieved by the precise regulation of several factors. First, the temperature of the various compounds must be maintained at a constant level. These compounds are then fed into a mixing chamber by pumps capable of constantly metering the flow at a predetermined rate and pressure. The mixing head must be designed to permit a wide variety of mixing speeds at various viscosities and pressures, so that the material can be ejected at the right moment during the chemical reaction. Nozzle orifice dimensions for each formulation must be carefully controlled and mixing head drive speeds must be regulated to ± 2 to 5 r.p.m. Imperfect design of any of this equipment will result in imperfect "blows" involving variable cell size, fluctuations in density, collapse, "blow holes," and curing difficulties.

Once the material has left the mixing head, it is affected by other conditions which must be correctly controlled before a perfect blow is achieved. The temperature of the mold is critical for some formulations.

Rigid foams also are susceptible to variations in temperature. Unless the temperature follows the exothermic reaction of the formulation, density may vary as much as 25%, or the blow may even collapse. This temperature must be experimentally determined for each new formulation.



Polyurethane foam lining (see cross-section, below) for new vacuum bottle (above) is designed to take advantage of the insulating qualities of the material. (Photo, Du Pont)





Foamed polyurethane crash helmet lining is removed from aluminum mold prior to being placed in infra-red oven for cure. (Photo, American Latex)

Mold design

The configuration of the mold or blow pan is yet another factor that affects the material. Where the cross-section of the mold is relatively small and there is considerable friction between the mold walls and the foaming material, a much higher density may be obtained at the extremities of the blow than at the center, and heavy skins may be formed. This is explained by the fact that, since the material itself is an excellent insulator, the exothermic action of foaming is contained in the center of the blow, but is conducted away by a thin-walled mold. Conversely, there is less drag and lighter densities created at the edge of a blow in a thick-walled mold.

After the polyurethane has foamed, a proper heat cure is necessary to assist molecular cross-linkage and create a fibrous type of foam with excellent properties. *If the material is to be used at elevated temperatures, the cure temperature must exceed the maximum temperature expected in its application.* Finally, the mold must be cooled before removal of the foam to prevent distortion of the final product.

Both rigid and flexible polyurethanes can be easily fabricated by sawing, slicing, grinding, drilling, or by using any of the techniques common to woodworking, including gluing. It can be colored in the manufacturing process with commercially available dyes and pigments.

Production of polyurethane

foam requires careful safety procedures. Vapors generated during the blowing stage are somewhat toxic. Injurious amounts of gas can be produced even by small amounts of spillage. Adequate ventilation is required.

As a safety measure, it is recommended that each man scheduled to work the polyurethane production line be required to undergo a complete physical examination and blood check beforehand and every 90 days during the period that he works in the area.

Production equipment

One of the most important developments in the field has been the design of suitable machinery for the continuous production of urethane foam. Basically, these machines consist of accurate proportioning pumps which feed the raw materials into a mixing chamber. From the chamber, the ingredients are forced through a nozzle into a pan or mold where the foaming and curing reactions occur. To produce continuous slabs (in dimensions that can go as high as 80 in. wide and 11 in. high), the mixing chamber and nozzle are mounted on a track so that the curing pans or molds may be passed beneath it on a conveyor. The length of the conveyor is such as to permit the foaming action to be completed and the foam to cure sufficiently so that it may be handled.

More recently, a portable (3 by 5 by 4 ft.) self-contained, fully-automatic polyurethane foam production unit has been placed on the market. Another portable model is also available to permit foamed-in-place work within a radius of 20 feet.

These machines meter polyurethane component ratios to within 1 g. of predicted density at a normal production of from 5 to 25 lb./minute. Adjustments incorporated into their design will permit standardization of almost infinite variations of density and elasticity.

One unit features a central control panel enabling a semi-skilled operator to start the machine, adjust all necessary pressures, temperature, and flow without the need to make internal adjustments. The operator adjusts for desired temperature, sets the pumps in motion, and first allows one component to flow through the mixing unit for the purpose of calibrating volume. After calibration, the flow of other components is adjusted until all are at the desired ratio.

CELLULAR CELLULOSE ACETATE

BY DR. P. J. WITTE*

Applications

Expanded cellulose acetate, known to industry as cellular cellulose acetate (CCA) or Strux, is a unicellular product produced by a continuous extrusion process wherein cellulose acetate flake is converted to a rigid foam by the flash vaporization of volatile solvent.

Density of the product is a function of both feed composition and operating conditions in the extruder. Foam in the density range of 6 to 7 lb./cu. ft. is presently available, in boards or rods.

A rather dense, smooth skin is present along the entire surface of the product as extruded. Immediately after extrusion the product passes through a pair of parallel circular saws where the edge surfaces are removed and width dimension is established. Removal of all skin results in a decrease in over-all density of about 1 lb./cu. foot.

A distinct advantage of continuous extrusion is that the length of product is unlimited. However, the cross-sectional area is governed by the capacity of the extruder, which, at present, is 6 sq. inches.

Conventional sizes are as follows: 1 by 4 in.; ¾ by 6 in.; ½ by 8 in.; 1½ by 3½ in.; 1½ by 4 in. in boards; and 2¼, 2⅜, and 2½ in. diameter rods. Other dimensions and shapes depend on availability of forming dies.

Besides the excellent strength properties shown in Table I, p. 344, Strux is noted for its thermal resistance and stability. For instance, it may be subjected to temperatures as high as 350° F. for extended periods, and up to 380° F. for short periods, without decomposition. Mechanical properties are not greatly affected by temperature change. At —70° F. room temperature values are decreased only 20 percent. The coefficient of linear expansion of 2.5 $\times$ 10^{-5} in./in. for 1° F. and a thermal conductivity of 0.31 B.t.u./hr./ft.^{2}/°F./in. of thickness further indicate good thermal properties. A burning rate of 4.9 in./min. presents the only feature of thermal weakness.

The water absorption of Strux, expressed in terms of reserve buoyancy after complete immersion in water, indicates an initial buoyancy of 55 lb./cu. foot. This value is reduced to 53 lb. after 24-hr. immersion. Four days of subsequent immersion decreases the buoyancy to 52 lb./cu. ft., at which point stabilization is obtained. Drying results in complete recovery.

Cured CCA has no odor. Toxicity has been thoroughly investigated. The basic ingredients themselves are known to be nontoxic. Since there are no volatile or unstable components present, the formation of toxic elements with an increase of temperature, pressure, moisture content, or other influences is impossible.

Strux is used extensively as a core material in sandwich constructions. In other fields, Strux has found acceptance as reinforcement for aircraft control services, radome housing, and filler blocks under fuel cells. As a buoyant material, it is indicated for life floats, buoys, and other flotation devices. Its dielectric qualities make Strux useful in the manufacture of X-ray and electronic equipment. Particularly important applications include ribs, posts, and framing members in shelters, housing units, trailers, and similar large structures.

One of the most extensive uses of CCA is in gun plugs for jet fighters. Since Strux can be machined to extremely close tolerances and has great strength even at high pressures, the plugs stay

* Director of Research, Russell Reinforced Plastics Corp., 521 W. Hoffman Ave., Lindenhurst, N.Y.

TABLE I: Properties of cellular cellulose acetate

Mechanical properties	
Tensile strength, 77° F., p.s.i.	170
Compressive strength, ultimate, p.s.i.	125
Flexural strength, p.s.i.	147
Modulus, p.s.i.	5500
Shear strength, in tension, p.s.i.	140
in compression, p.s.i.	140
Impact strength, Izod unnotched, ft.-lb.	0.1
Thermal properties	
Coefficient of linear expansion per °F.	25×10^{-5}
Thermal conductivity, B.t.u./hr./ft.²/°F./in.	0.31
Miscellaneous properties	
Density, lb./cu. ft.	6–7
Moisture absorption	
50% RH, lb./cu. ft.	0.15
100% RH, lb./ cu. ft.	1.05
Dielectric constant	1.12
Loss tangent	0.002–0.003
Burning rate, in./min.	4.9

in place during flight. When the gun is fired, the plug completely disintegrates, passing through the jet stream without any damage to internal mechanisms of the ship.

Recently, this foam has been utilized in an experimental packaging unit for shipment of antipersonnel mines and detonators. The high shock- and vibration-resistance of Strux allows packaging of these items in the same parcel. Because of these two properties, cellular cellulose acetate also is useful as a protective covering for batteries.

Techniques

Foamed cellular cellulose acetate is easily machined to extremely close tolerances by ordinary woodworking tools such as band- and circular-saws, lathes sanders, jointers, shapers, planers, and centerless grinders. It is important to note that the strengths are maintained throughout these operations even though skin surfaces have been removed.

It is sometimes required in certain applications manually or mechanically to shape Strux sections to a particular contour. Extruded parts have reasonable flexibility in the direction of extrusion and can be formed in large radii and simple curves, especially in thin sections after skin removal. Flexibility can be increased to a degree by subjecting the piece to hot water or steam for short periods. Dry heat is not effective.

As mentioned previously, since the cross-sectional area of cellulose acetate foam is limited, it is necessary to build up sections where larger areas are required.

Simple gluing procedures work well with this material. Fabricators have used polyester and epoxy resins, particularly where vertical surfaces are encountered, utilizing thixotropic or thickened resin mixes which have little tendency to flow or run due to gravity. Also used are phenol-, urea-, and resorcinol-formaldehyde-type adhesives.

Single-component systems such as those offered by the vinyl- and rubber-base cements are more satisfactory on small-scale operations. Besides elimination of mixing, these types are usually lower in cost and, even more important, have almost unlimited pot life in a sealed container.

One of the most important applications of Strux is in the field of sandwich construction. Because of its high heat-resistance, its high strength-low weight ratio, and ease of bonding, it is well-suited for production of laminates using glass cloth, glass mat, metal, or wood in combination with polyester and epoxy resins. This can be done either by primary or secondary bonding. In primary bonding, the CCA core is merely laid continuously between resin-impregnated facing materials and placed in a press under a pressure of about 30 p.s.i. for 10 min. at 230° F. The resin flows between the individual joints, providing a sound bond and eliminating the need for any preliminary bonding of the CCA sections. Secondary bonding requires roughening the surfaces of the facing material and utilizing the gluing techniques mentioned above.

EXPANDED POLYSTYRENE

BY R. W. THEOBALD*

Applications

The fabricator or consumer of expanded polystyrene, made by The Dow Chemical Co. under the trademark Styrofoam, obtains the material in its already expanded form (in blocks, sheets, etc.) and thus he need only concern himself with its fabrication or installation into commercial items. A wide range of properties may be obtained from the various forms of expanded polystyrene and a large number of end uses are possible through the proper choice of available materials.

Polystyrene foam is presently available to the market in densities of 2.0, 3.0, and 4.5 lb./cu. foot. In addition to this low density, these materials have a closed-cell structure and possess a low thermal conductivity, good moisture resistance, fair structural strength, ease of workability, and no attraction for vermin. Because of these properties, polystyrene foam finds extensive application as temperature insulation, as a core material in sandwich construction, as a buoyancy medium, and in packaging. Its pleasing appearance and ease of fabrication make it an excellent material for various decorative and utilitarian applications in the floral, display, and novelty fields.

Among the attributes of poly-

* Plastics Technical Service, The Dow Chemical Co., Midland, Mich.

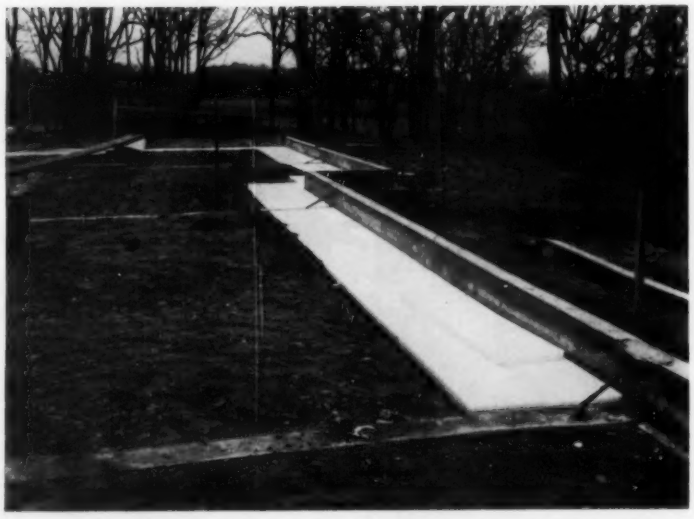
styrene foam in low-temperature insulation is a compressive strength high enough to permit the placing of concrete or metal floors directly over the material without additional support. The unicellularity of this polystyrene foam prevents the absorption of water or water vapor and insures against any decrease in insulating efficiency. This fact is of great importance where chilling or freezing temperatures are encountered. It is important, too, where the insulation is to be laid directly in the ground, as in residential perimeter floor slab insulation.

The low thermal conductivity, good structural strength, and rough surface texture of polystyrene foam facilitate its use as a combination insulation and plaster base in residential masonry construction. Direct plastering over the foam is not only feasible but practical, as the surface requires no preparation in order to be able to receive the plaster.

The high shear-strength of polystyrene foam makes it an excellent core material for sandwich panel construction, especially where a lightweight insulating panel is required. Skins for these panels may be of plastic, metal, wood, cement, or any of a variety of other materials and may be bonded on either one of both sides, depending on the use to which the panels will be subjected. These panels have been used successfully in trucks, commercial buildings, schools, and houses as wall and roof panels. Light weight with strength and ease of installation are some of the benefits gained from using panel construction.

Packages and display platforms fabricated from polystyrene foam offer both a pleasing appearance and a measure of protection for the contents. It will absorb considerable shock on impact and can thus be used to protect fragile articles in shipping and warehouse handling. Display bases made of the foam are also attractive for small articles and function as a sales aid to the retailer in his promotions.

Polystyrene foam is used extensively in the field of buoyancy by virtue of its light weight and closed-cell structure. With a buoyancy factor of 55 lb./cu. ft., this foam is being used by boat manufacturers to replace airtight compartments. The use of the foam eliminates the danger of total loss of buoyancy because of puncture or corrosive perforation. The foam is also being used to give buoyancy to life rafts, swimming rafts, aquaplanes and navigation buoys, as well as floating docks.



Low moisture absorption of expanded polystyrene foam is important in use of the material for perimeter insulation of residential floor slab. (Photo, Dow)

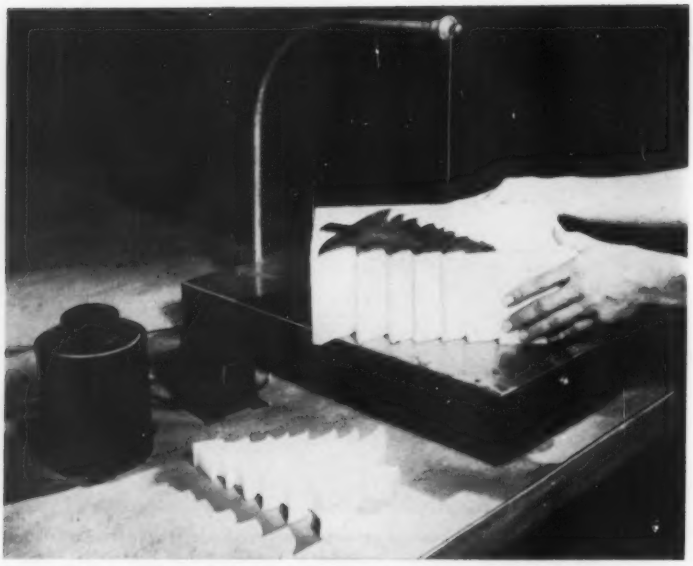
The floral field is finding polystyrene foam useful because its cellular structure holds the stems of most flowers firmly in place. Also important in this application is the lightness, ease of fabrication, and inherent attractiveness of the material. The display and novelty field uses the foam extensively for holiday decorations, window and counter displays, carvings, and signs. Colored polystyrene foam is now being produced in red and green primarily for the display and novelty fields, and olive green for the floral market.

Techniques

The lightweight foam produced by expanding polystyrene up to 40 times is available in several forms—standard white Styrofoam 22; a self-extinguishing type known as Styrofoam 33, colored

Expanded polystyrene foam cores in sandwich materials used for side walls and roof of house combine light weight and insulating effectiveness. (Photo, Dow)





Curved surfaces, such as in this Christmas tree decoration, can easily be cut in blocks of expanded styrene with an electrically heated wire. (Photo, Dow)

blue for identification purposes; a medium-density foam which weighs approximately 3 lb./cu. ft. and a 4½ lb./cu. ft., high-density material. Also available are foaming-in-place beads which, under heat, can be formed to densities as low as 0.5 lb./cu. foot.

Cutting

Polystyrene foam can be readily cut to desired shapes with conventional hand or power woodworking tools. Power saws, lathes, shapers, and routers may be used to fabricate the foam to various shapes without the use of special techniques. As examples, symmetrical objects may be fabricated by feeding a flat blade having the desired contour into a rotating piece of the foam, or a piece may be hollowed out with a flat blade type of router. Nonsymmetrical pieces are either carved by hand or on a multiple woodcarving machine. In any type of mechanical cutting it is generally most satisfactory to operate the moving part at high speed using a slow feed, thus making many small cuts.

Plain and curved surfaces may be cut with an electrically-heated wire. Fabricating polystyrene foam by hot wire requires more technique than using woodworking equipment, since the cut involves the special skills needed for melting and shrinking of the cell structure.

In using this cutting method, a piece of the foam is fed into a shaped nichrome wire or ribbon that is held at a temperature just below red heat. The amount of power required to heat the wire depends on the rate of cutting and the width of cut desired. At any given wire temperature the width of cut will vary with the rate of feed, i.e., the slower the rate of feed the wider the cut.

Several methods of heating the nichrome wire or tape have proved effective and capable of giving the necessary control. A low-voltage, high-amperage transformer (5 to 10 v., 50 to 100 amp.) or a standard electric arc welder have proved satisfactory. Thin sections of the foam can be die-cut successfully. Either a heated melting-type cutter or a shear-type cutter may be used, depending on the piece being fabricated.

Polystyrene foam can also be cut into intricate designs with various conventional woodworking tools. (Photo, Dow)



Bonding

Polystyrene foam may be successfully bonded to itself and to most other materials, including masonry, wood, cloth, paper, glass, and metal. The rough surface of the foam is ideally suited to mechanical bonding; however, other characteristics such as low melting temperature, susceptibility to strong solvents, and low vapor transmission limit the number and variety of adhesives that may be used.

Drying-type (setting by evaporation of a liquid) adhesives containing active solvents such as aromatic and chlorinated hydrocarbons, ketones, and esters are generally not satisfactory for use with polystyrene foam. These materials are solvents for polystyrene and, upon contact with them, the foam will shrink, soften, and dissolve. Solvent attack is evidenced by an apparent melting or shrinking of the cells.

Adhesives containing nonsolvents for polystyrene such as the lower alcohols and water are satisfactory in applications where the solvent can evaporate. This group includes the many water-dispersed emulsion and latex types of adhesives. Because of the low vapor transmission rate of polystyrene foam these adhesives are generally suited only for bonding the foam to vapor-porous materials, such as wood, masonry, paper, and cloth. However, they can be used on nonporous materials if sufficient open time is allowed to permit the adhesive to dry partially before the bonding surfaces are joined, or where spot or serrated application gives sufficient bond strength. Sections no greater than 2 in. may be bonded without concern when the drying can proceed through the glue line. Adhesives

containing petroleum naphthas as solvents can often be used similarly to adhesives containing non-solvents if caution is observed. These adhesives should be applied to the material to which polystyrene foam is to be bonded and most of the solvent allowed to evaporate before the foam is finally put in place.

Cold-setting types of adhesives that harden and set by a chemical process are generally well-suited for bonding polystyrene foam. It is important, however, to find out by testing whether the adhesive will bond to the material to which the foam is to be adhered. The adhesives in this group include water-reactive materials (portland cement, plaster of paris, etc.) and the types that set by polymerization and/or oxidation (epoxies, phenolics, resorcinols, ureas, and the like). Polyester resins containing styrene monomer are not satisfactory for use with polystyrene foam unless it is very carefully protected against the solvent action of styrene monomer. Hot-melt adhesives, usually asphalt- or wax-based materials, may be used as bonding agents for the foam if they have a workable fluidity at temperatures below 300° F. Polystyrene foam distorts when subjected to prolonged exposure at 175° F. It can, however, be immersed in a molten adhesive for a short period of time, long enough to obtain a coat of the adhesive on the surface. The maximum temperature at which this should be done is 300° F. Hot-melt adhesives usually perform best at the highest permissible temperature. When the temperature is too high, the cells of the foam melt, emitting a crackling sound.

Surfacing and decoration

Many types of surfacing materials can be applied and adhered to polystyrene foam because of its tough surface. Plaster, for example, can be applied directly on the foam. Where reduction of weight is important, a pulp plaster can be applied to provide the required surface. Other types of protective surfacing materials that can be applied successfully to polystyrene foam are the rubber- and asphalt-based water-dispersed weather coatings. Epoxy resins are quite compatible with the foam and form excellent surface coatings. They may be reinforced with glass fibers for added strength.

Polystyrene foam may be painted to practically any desired color. Care should be taken, however, to see that the solvent used in the paint is not one (e.g., aromatic and chlorinated hydrocarbons, ketones, and esters) that attacks polystyrene foam under the conditions of application. In general, paints for use with this foam should be based on film formers that are dispersible or soluble in aliphatic hydrocarbons, alcohol, or water.

All commercial oil paints should be tested for solvent action before being used, since certain of them are thinned with aromatic hydrocarbons which attack polystyrene foam. Even such paints can be applied if care is observed in application. Spraying is the most satisfactory technique for coating the foam, but brushing is often used with good results.

Water-based paints are most successful for applying a colored surface to the foam. The resulting surface, however, is not glossy and two or three coats are sometimes necessary in order to cover all of the surface cells.

Coatings of varying hardness and flexibility may be formulated from alcohol-soluble, film-forming materials such as ethyl cellulose, shellac, and polyvinyl acetate. These coatings provide a tough protective surface and also may be pigmented or dyed to give glassy colored surfaces.

Polystyrene foam can also be colored by using any number of water-soluble or alcohol-soluble dyes.

EXPANDABLE POLYSTYRENE

BY EDWIN A. EDBERG*

Applications

Foam from expandable polystyrene features characteristics which make it useful in diverse fields. Salient properties are closed-cell structure, controllable density, low thermal conductivity (K factor), low water absorption, low water vapor permeability, toughness, excellent dielectric characteristics, and all-around adaptability. Polystyrene foam is dimensionally stable at ambient temperatures to 175°F. It is resistant to acids, alkalies, and the lower alcohols, but susceptible to attack by polystyrene solvents such as ketones, esters, and aromatic hydrocarbons.

Expandable polystyrene foam does not become brittle at low temperatures. Unnotched impact tests on specimens at a density of 4 lb./cu. ft. stored at −100°F. for 48 hr. indicated no loss in impact resistance.

The water absorption of the material is extremely low. The non-interconnecting cell structure prevents the absorption of water into the interior of the molded article by capillarity. The (low) water absorption after 8 days immersion at room temperature is as follows: less than 0.5% by volume and 15.8% by weight (0.0156 lb./sq. ft. of surface area). These values are for foam at a density of 2 lb./cu. ft. and repre-



Contoured platforms of shipper-display package for barber kit are molded of expandable polystyrene. After sale, package can be used as storage box. (Photo, Ambassador Plastics)

* Manager, Dylite Expandable Polystyrene, Market Development, Koppers Co., Inc., Chemical Div., Monaca, Pa.

sent maximum water absorption for the material. Higher-density material will show proportionately lower water absorption values. Under a hydrostatic pressure of 10 ft. of water for 48 hr., absorption is less than 1.5% by volume.

The water vapor transmission of the material is also very low. The rate is 0.5 to 1.0 grains/hr./sq. ft./in. of thickness/in. Hg vapor pressure difference, when measured by A.S.T.M. Method D697-42T.

End-uses

Expandable polystyrene's capacity for accurate registration of mold detail led to its early and still-growing use in making toys, novelties, and displays. Silk-screened, dry-colored, and artfully beribboned articles in this category have found popular success and many more markets in the same area remain to be tapped.

Expandable polystyrene has also found a ready market in low-temperature insulation. An excellent low-temperature pipe insulation, for instance, can be produced at low cost by inexpensive molding techniques. Board insulation is finding enthusiastic acceptance for the construction of coolers and freezers. Refrigerator drip trays, freezer evaporators, evaporator supports, and liner shields of expanded polystyrene are being extensively used in the domestic refrigeration industry.

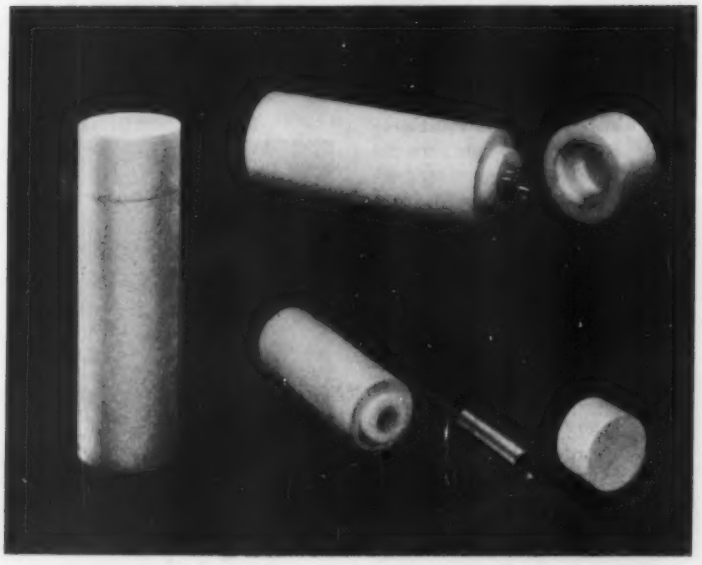
Consumer, industrial, and military packaging problems have been successfully solved with easily-molded, shock-resistant, low-density expanded polystyrene. Its strength, water resistance, and insulating qualities have led to its use for shipping containers for whole blood, plasma, and perishable drugs. Delicate instruments and intricate parts are cushioned against transportation and air-drop shocks by dunnage readily molded from the expandable polystyrene beads.

Foamed polystyrene core boxboard has recently appeared on the market. Greatly increased wet strength, excellent insulation, and enhanced cushioning over conventional material have been obtained from boxes made from the expanded polystyrene board.

Sandwich constructions in which the polystyrene is foamed at controlled densities between sheets of plastic, plywood, and aluminum show promise in the construction field.

Expandable polystyrene also has exceptional buoyancy characteristics, and "in-place" moldings are being used in boats, buoys, etc. to replace air t[illegible]s. Puncturing such molded p[illegible]s will not affect their buoy[illegible]y characteristics.

For protection from damage due to mechanical shock in transit, a container molded of expandable polystyrene is used as the shipper for a vibrating reed. Top of cylinder is easily pulled off (inset). (Photo, Ambassador Plastics)



Techniques

Expandable polystyrene is [illegible]o-duced as free-flowing beads [illegible]n-taining an integral expan[illegible]g agent. When exposed to h[illegible]at, these beads "puff" from a bulk density of approximately 35 lb./cu.ft. to as low as 0.25 lb./cu.foot. The expanded beads show an interesting increase in resilience at very low densities. Moldings have been produced at densities under 0.5 lb./cu.foot.

Foaming expandable polystyrene beads ordinarily comprises two discrete steps: 1) heat pre-expansion of the virgin beads; and 2) further heat expansion of the pre-expanded beads within the shaping confines of a mold.

Extrusion and virgin bead molding are the chief exceptions. In unconfined pre-expansion, the translucent beads assume spherical shape and become white in color. Confined and subjected to heat, either the virgin or pre-expanded beads can produce a smooth-sk[illegible]nned, closed-cell foam of controlled density registering every detail of an intricate mold.

Pre-expansion

To minimize formation of a density gradient and to ensure uniform expansion, expandable polystyrene beads are pre-expanded to the approximate required density.

Batchwise, pre-expansion is suitable for preparing small quantities for experimental purposes if close control of the pre-expanded density is not critical. A common infra-red heat bulb is mounted 4 to 5 in. above a tray and the beads distributed in a thin layer over the bottom of the tray and allowed to expand.

Continuous pre-expansion is presently accomplished by moving belt or disk exposure of the beads to infra-red strip heaters, by screw-fed exposure to hot water, and, most recently, by introduction into a stream of steam and air and subsequent agitation in a closed container.

Oldest and most amenable to

"pre-puff" density control is the method of continuously feeding the expandable polystyrene beads in a monolayer to a conveyor belt passing under a bank of infra-red strip heaters. The lacy network of pre-expanded beads is readily broken up in a breaker at the end of the machine. Bulk densities of 1.5 lb./cu.ft. to 20 or more lb./cu. ft. can be obtained with a commercially available belt pre-expander. Desired densities are obtained by varying belt speed, height of heaters above beads, and electrical input to heaters.

High-volume, low-density (1 lb./cu.ft.) steam pre-expansion equipment has shown considerable promise and will soon be available commercially. Virgin beads are sucked into a steam/air stream and ejected into a suitable receiver equipped with an agitator. Pre-expanded beads emerge continuously from the top of the receiver and are conveyed by air to suitable hopper storage.

Fairly high-volume, low-density pre-expansion has also been achieved by feeding virgin beads into a screw revolving in water above expansion temperature.

Processing

"Expansion" or "molding" of expandable polystyrene beads requires exposing the pre-expanded or virgin beads to heat in a confined space. The confining space may be a mold, a structural form such as a boat hull, or the lips of an extruder die. Heat can be supplied by direct steam introduction, by "in situ" steam formation, and with normal extruder heating equipment.

Relatively simple and inexpensive molds of aluminum, brass, and stainless steel are used. They must be provided with some means of clamping—a light press or "C" clamps will often do. Lands of the molds should not be too well finished, since some roughness of the parting line will permit escape of steam condensate "squeezed" from the molded piece. Hand-filling is satisfactory in many instances, but venturi tube loaders have provided uniform blow-filling in fast cycle production setups.

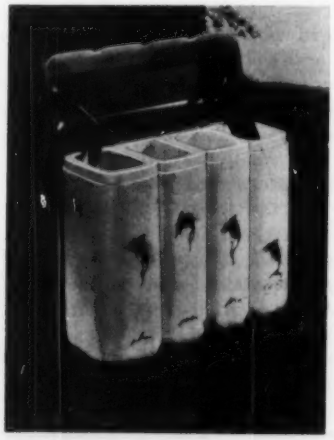
Where the physical construction and configuration of the cavity permit the use of steam, "foaming in place" can be accomplished. Boat hulls and refrigerator shells lend themselves readily to this treatment.

Extruder dies must be specially designed to control expansion but can be used on conventional plastic extruders.

Expansion techniques

Direct introduction of steam into the mold cavity is the fastest way to accomplish expansion. The latent heat of the steam causes expansion of the beads in a matter of seconds. Three procedures have been developed for introducing steam into mold cavities:

1) Perforated cavity plates backed by suitably-baffled steam chests. Cavity walls should be as thin as consistent with good design practice and the perforations made 1/32-in. in diameter and placed one hole for every 2 sq. in. of surface area. Single and multi-cavity molds of this type in suitable air and hydraulic presses have been used to produce display and packaging pieces, toys, and refrigerator components. Expansion times with these molds range from 10 to 90 sec. at from 10 to 40 p.s.i. steam pressures, giving temperatures of 230 to 275° F. Cooling times range between 1 and 5 min., depending on the conformation of the piece and the cooling provisions built into the mold. The molded piece must be cooled below 122° F. before release from the mold to prevent postexpansion.



Carry-all kit for sportsmen is molded of expandable polystyrene. Kit weighs only ½ lb. and will float even when filled. (Photo, Bucks Industries)

2) Small runs of small objects are often made by exposing a filled perforated mold to steam in an autoclave capable of rapid steam pressurization to about 30 p.s.i. A small laboratory autoclave or a sealed-off pipe section can often serve as a pressure vessel for experimental work. Expansion times vary from 2 to 5 min. at operating pressure for small objects, while large ones may require 10 to 15 minutes. Cooling is usually effected by atmospheric cooling, water spray, immersion in water (quench cooling), or some combination of the three.

3) An exceptionally versatile technique for direct introduction of steam into cavities involves use of a simple steam probe. Aluminum, copper, or brass tubes are sealed at one end and attached to a flexible hose or header at the other. Four rows of 1/32-in. diameter holes, spaced 1 to 1½ in. apart at 90° intervals, are normally bored in the tube, although other spacings and row-staggering can often be employed to good effect. The effective steam penetration radius of a single probe is about 6 inches. When more than one is required, probes should be spaced 10 in. apart, except that intricate designs and large-area moldings may require closer and more carefully-planned spacings.

Foaming-in-place is most often accomplished by the probe technique. Large buoyancy members, insulated wall sections, and in-place sandwich structures are common products of this technique. Immediate withdrawal of the probes after 10 to 15 sec. of 20 to 30 p.s.i. steam injection allows the material to close up the probe holes by expansion. Cooling the pieces with probes in place leaves well-defined holes.

Minor techniques for combining probes with headers, flexible hoses, and multiple-outlet, timer-controlled steam chests have been developed and make steam a reliable, all-purpose method of expansion.

Expansion times with steam probes ordinarily range between

10 and 75 sec. and steam pressures between 20 and 40 pounds. Air, water spray, and water immersion cooling can be used. Probes can also be equipped to circulate cooling water through large pieces.

"In situ" steam formation is often used in the experimental phase of a new expandable polystyrene molding project. An inexpensive, unperforated cavity shell is filled with a slurry of beads and water, clamped, and heated in an autoclave or oven. The water generates steam on heating and distributes heat evenly throughout the mold. Polystyrene foam is an excellent heat insulator and only an outer shell would fuse were water not present. This is slower than direct steam introduction, but low cost commends it in experimental work.

Rotating molds, filled with dampened beads, not yet expanded, will produce pieces of exceptionally uniform density because the rotation eliminates the density gradient characteristic of stationary virgin bead moldings.

Extrusion: Conventional extruders with low compression screws and high L/D's are suitable for extruding a special grade of foam through profile dies. Expansion occurs at the die lips, and die profile design requires considerable experimentation. Rods, tubes, and film have been satisfactorily produced.

CELLULAR POLYETHYLENE

BY J. A. SNYDER*

Applications

Cellular polyethylene is, as the name describes, polyethylene containing independent cells of inert gas or air. The number and size of the cells which are in the foam are usually uniform, so that the surface of articles formed from this material is even in texture and pleasant to the eye. Methods of forming vary. The most common is the extrusion process, which produces continuous lengths of varied shapes; the compression molding process is also employed with success; but, although vinyl, phenolic, and rubber foams are produced in large volume by this process, its commercial use is not yet widespread for polyethylene. Injection molding has been accomplished with relatively little commercial success to date.

In the form of extruded rod, disks sliced from rod, and disks stamped from sheeting, cellular polyethylene is used in such minor varied applications as: lightweight spacers, bumpers on small boats, and bottle cap liners. However, the largest application by far today is primary insulation for communication cables: coaxial cables, television lead-in wire, and other high frequency cables. The inherent properties of polyethylene — chemical, moisture, and abrasion resistance plus flexibility and toughness—are adequately retained when polyethylene is foamed. In addition, the capacitance of the foamed insulation is reduced to levels even lower than that of the solid polyethylene. The dielectric constant of the cellular insulation most commonly produced is 1.5 compared to 2.3 for solid polyethylene.

Table I, below, gives some typical values for the physical and electrical properties of cellular versus solid polyethylene.

* Development Dept., Bakelite Co., Div. of Union Carbide Corp., Bound Brook, N. J.

TABLE I: Typical properties of cellular polyethylene insulation

Property	*Solid polyethylene*	*Cellular polyethylene*
Tensile strength[1], p.s.i. at 23°C.	2180	670
Elongation[1], %	600	310
Dielectric strength. A.S.T.M. D-149-55T		
Short time at 0.125-in. thickness, v./mil	550	220
Step by step at 0.125-in. thickness, v./mil	500	190
Specific gravity, 23/23°C.	0.92	0.42
Mandrel bend[2] at —55°C. & 2X	O.K.	O.K.
Dissipation factor at 1 kc.	0.00020	0.00030
10 kc.	0.00020	0.00035
50 kc.	0.00020	0.00035
Dielectric constant at 1 kc.	2.28	1.48
10 kc.	2.28	1.49
50 kc.	2.28	1.50
Compression loading[3], p.s.i.	1550	450

[1] 32-mil specimen stripped from No. 14 AWG wire.
[2] Test made on a No. 14 AWG wire with a 93-mil polyethylene coating.
[3] Test made on a No. 14 AWG wire with a 32-mil polyethylene coating.

Moisture resistance

For many electrical applications, exposure to moisture is unavoidable. Therefore, to insure continuous and consistent service, the absorption of water by the insulation must be at a minimum. Cellular polyethylene is slightly less resistant to moisture permeation than solid polyethylene of equal thickness. However, due to a balancing of external and internal vapor pressures, cells do not become filled with liquid water, and relatively little water is absorbed. Figures 1 and 2, p. 351, show the dielectric constant and water absorption plotted against water immersion time for solid and cellular polyethylene insulations of similar thickness. A relatively small increase in moisture content during immersion is noted in the cellular insulation during the first 30 days and then no further change is noted through the remainder of the test period of 100 days. No significant change in dielectric constant is observed.

Good moisture resistance and 50% weight reduction have made possible a floating geophysical cable in which the lines are coated with cellular polyethylene. This floating cable permits the usage of more complicated communication systems and greater power consumption at points miles from shore without handling cumbersome equipment.

Foamed polyethylene has been

tested as a thermal insulator. Because of its relatively low melting point, its use must be restricted to applications where temperatures remain under 90° C. Excellent chemical properties indicate cellular polyethylene's possible future use as an insulator for chemical laboratory refrigerators and cold boxes. Figure 3, right, presents the thermal conductivity versus density.

While it is widely used today as a dielectric material in high-frequency cables, foamed polyethylene is still a neophyte in the cellular plastics field. Major economical advantages in weight reduction and an excellent combination of chemical, electrical, and physical properties are expected to create new and even more important uses soon.

Techniques

Cellular polyethylene is produced by the extrusion of a polyethylene compound containing an intimately dispersed chemical blowing agent. Extrusion can be accomplished with conventional equipment.

The correct choice of the blowing agent used in the production of cellular polyethylene for an electrical end-use product is a critical one, and it must meet several unusual requirements. To maintain the inherent electrical properties of the polyethylene, the blowing agent, the gas liberated by it, and any residual products must not absorb moisture and thereby degrade the insulating characteristics of the compound. The blowing agent used should liberate a maximum of gas and leave a minimum of residue. The residue should be nonpolar so that the low-loss characteristics of the polyethylene insulation will not be impaired. In applications where the electrical properties are not of great importance, other parameters for the blowing agent specific to the particular application are essential. For example, in bottle cap liner applications, the blowing agent and its residues must be nontoxic. In decorative sheets, color stability is a must.

Since the blowing agent must liberate gas under controlled

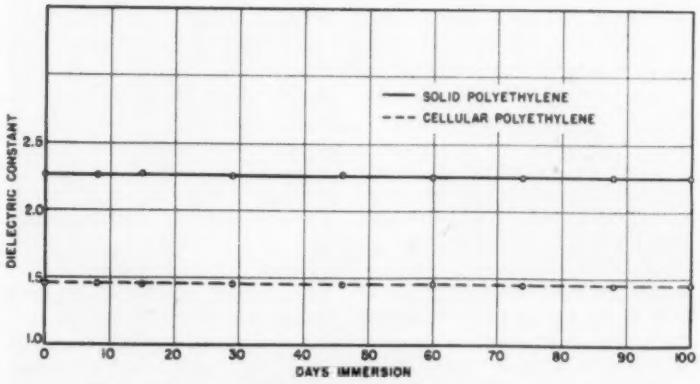


Fig. 1: Dielectric constant plotted against water immersion time for solid polyethylene vs. cellular polyethylene materials

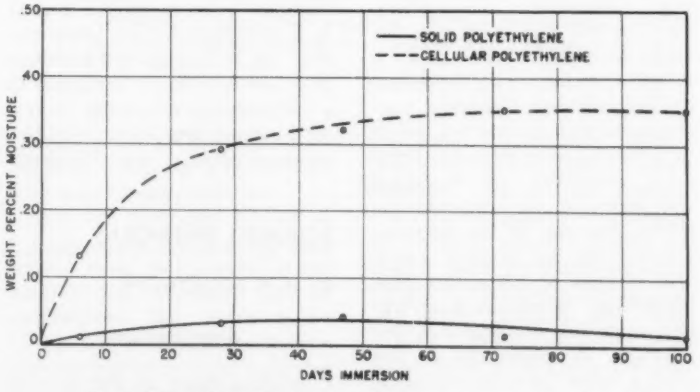


Fig. 2: Water absorption plotted against water immersion time for solid polyethylene vs. cellular polyethylene materials

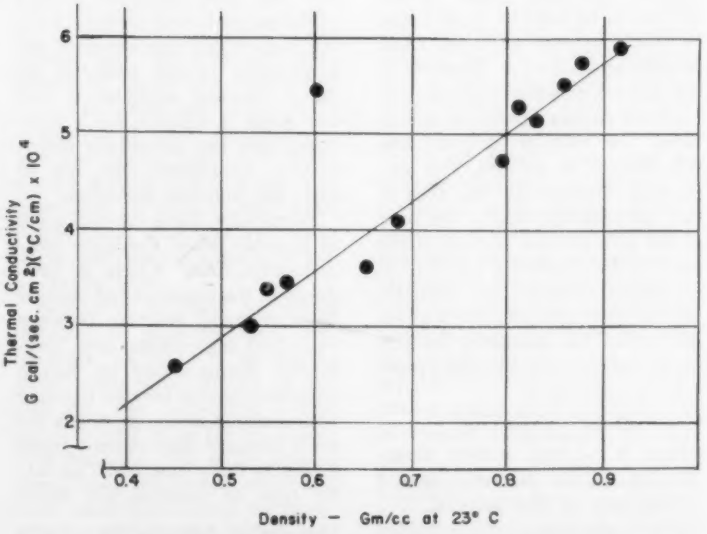


Fig. 3: Chart plotting thermal conductivity of cellular polyethylene vs. density

conditions, extruders that can be regulated both as to heat and pressure appear more adaptable to this critical operation. Aside from the actual extruding operation, the machine used in processing cellular polyethylene must perform two additional functions: 1) by application of heat, the extruder must cause the blowing agent to liberate the gas; 2) by maintaining uniformly high pressure in the barrel, head, and die, the extruder must ensure against premature expansion of the liberated gas before the material emerges from the die. A machine properly adjusted to heat and pressure will give a product with a smooth surface, a unicellular structure, and a uniform bubble size. Operating temperatures that are too high will give less uniform bubble size and a rougher surface with attendant cooling problems. Operating temperatures that are too low result in a high-density material. Optimum conditions for extrusion will vary with the particular extruder, the size of the extruded article, and the blowing agent.

A method of preventing premature gas expansion is to employ a die that develops sufficient pressure. A minimum of 1000 p.s.i. is usual for wire insulation, and pressures of 2000 p.s.i. are more satisfactory. High pressures can be maintained by employing double- or triple-tapered dies to lengthen the over-all die length. The land length of the dies must be kept to a minimum to insure smooth surfaces. Land lengths equal to the diameter of the die are considered maximum.

Under proper operating conditions, the cellular polyethylene will double in volume. This expansion requires that the area of the die opening, minus the area of the wire or core, be 50% of the area of the finished insulation. A convenient formula for computing the final diameter for a given die size or the necessary die size for a specific final circular cross-section diameter is:

$$D = \sqrt{2D_1^2 - d^2}$$

where D = final outside diameter, D_1 = die diameter, and d = diameter of wire or core.

For applications where higher densities are required, cellular stock can be blended with a solid polyethylene compound to achieve the desired density. Higher densities can also be obtained by extruding at reduced temperatures, thus limiting the extent of blowing. However, the results of limited blowing are extremely difficult to reproduce and, in every case, it is recommended that all of the gas be liberated from the blowing agent during the extrusion operation.

Screw temperature control is necessary with the insulation materials extruded today so as not to over-heat the compound. The exact temperature varies with the extruder. Temperatures from 20 to 100° C. have been used successfully. A screw length-to-diameter ratio of 12:1 or higher is more effective than lower ratios, while a high-compression-ratio screw is to be preferred to a low-compression-ratio screw of the same type. Screws of the constant-pitch, variable-depth type, with a three-to-four flight metering section, are found most satisfactory. Preheating of the wire or core to between 212 and 260° F. is desirable for achieving a smooth, regular surface. Lower temperatures tend to give a lumpy material; higher temperatures result in uneven cooling and flattening of the insulation.

While it is possible to use direct water cooling for thin-wall insulation, heavy walls require a long stretch of air cooling. Too rapid quenching of the product will tend to flatten it because of its weakness at the extrusion temperature. Another cause of insulation deformation is the rapid contraction of the occluded gases before the polyethylene has had an opportunity to develop strength. It is possible, however, to minimize these tendencies by using the lowest compound temperatures that will give complete blowing and good forming behavior in the die.

FOAMED PHENOLIC

BY R. P. COURTNEY*

Applications

Phenolics share in the general upsurge of experimentation and testing that has taken place in the field of plastics foams during the past year. One of the major results of this intensive examination has been improved control of the properties of phenolic foam —a feature that has increased the practicality of the material for many existing applications and has made it suitable for a relatively new and potentially large-volume application—the use of foam for building insulation.

Essentially, there are two types of phenolic foam available commercially—foam which is produced in the conventional manner by a chemical reaction between resin and ingredients, and "premixed" foams based on hollow phenolic spheres bonded together with various resins in much the same manner that cement binds gravel to form concrete. This latter type of material, for which the phrase "syntactic foam" has been coined, is unique among plastics foams, since its "foamy," or cellular, character depends on the hollow nature of the spheres, rather than on any chemical reaction.

Reaction-type foams

The reaction-type foam results from a reaction between phenol and formaldehyde (the constituents of a phenolic resin), a catalyst, and certain modifying agents. The prime characteristics of the foam produced are light weight, high stability, heat resistance up to 250° F., and nonflammability. It is also among the most inexpensive of plastics foaming materials. Since a composite structure, about 40 to 60% open and closed cells, is formed during foaming, phenolic foam is a good thermal insulator with some acoustical insulating properties as well.

In practice, phenolic can be foamed to densities ranging from ⅛ lb./cu. ft. all the way up to the density of nonporous resin, which is about 80 lb./cu. foot.

* New Products Engineering Dept., Bakelite Co., Div. of Union Carbide Corp., 30 E. 42 St., New York, N. Y.

Phenolic resin foam of commercial grades has its best thermal insulating value at a density of about 2 lb./cu. foot.

Phenolic foams that are of this density have a "K" value of 0.18 B.t.u./in./ft.^{2}/°F./hour. However a low-density foam does have better insulating properties when mechanically compressed to higher densities. Compressing low-density foam maintains the thin cell walls of such foam, while increasing the number of air cells in an inch of thickness. Thus, more insulating units per inch of thickness are provided, resulting in a lower "K" factor. Since increasing the density, either chemically or mechanically, increases the cost factor, it should be noted that a foam density of ⅓ lb./cu. ft.—which is one that has a "K" factor that is in the order of 0.26 to 0.28—is still within the range of insulation which is provided by the conventional materials.



Sandpapered to a fine texture and coated with a pore-sealing solution, phenolic foam may be worked as a handicraft material. (Photo, Bakelite Co.)

Building insulation

The motivating factor encouraging the use of phenolic foam for building insulation has been the successful development of installation techniques that make the best use of the foam's unusual properties. One such technique involves the installation of the foam conventionally by filling wall spaces with precut, factory-produced slabs. A more desirable technique, from the standpoint of economy and speed, is based on foaming the material into horizontal prefabricated panels and structures on a moving conveyor belt. As a result of recent developments, phenolic foam can also be adapted to foaming-in-place operations right on the building site.

Laboratory research has resulted in phenolic resin formulations which will foam in a vertical wall cavity to controlled heights, at whatever insulating density desired, and with uniform density throughout the structure. These properties are controlled by carrying out the reactions at high speed through the use of carefully prepared formulations. As an example of the speeds involved, an 8-ft. wall cavity, about 4.3 cu. ft. in area, is filled in less than 60 seconds. The foam permanently bonds itself to the wall, providing no-sag insulation.

Since the foam does not act as a vapor barrier, a separate material, such as plaster board backed with aluminum foil, or polyethylene film, needs to be added. To handle a continuous foaming operation, special mixing equipment is needed. Equipment of this kind is being made available commercially.

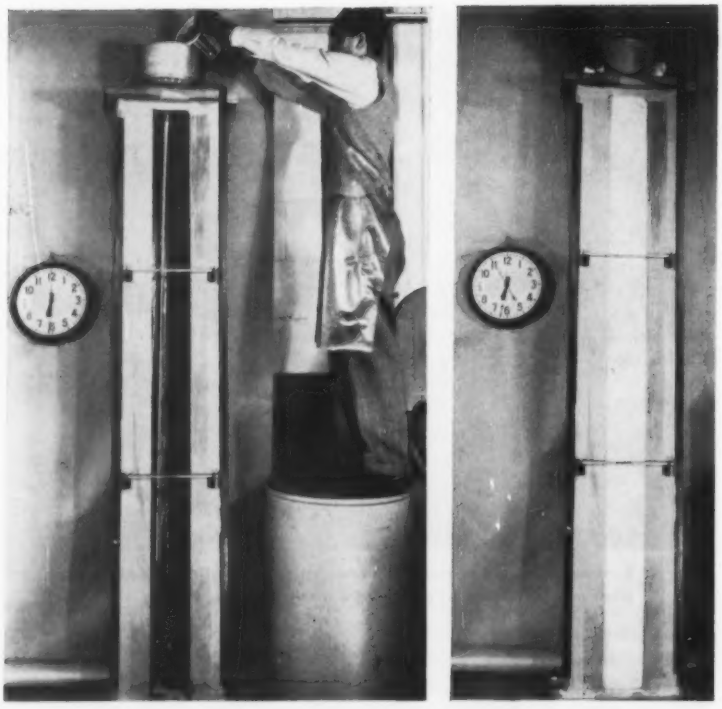
In addition to thermal insulation, reaction-type phenolic foam can also be used as a handicraft material. Formulated to the proper density and strength, foam blocks may be produced with almost no grain. The blocks can be cut smoothly and cleanly with simple hand tools. Sandpapered to a fine texture and coated with a pore-sealing solution, the new foam may be formed into vases, bowls, trays, desk sets, and other items, with an appearance similar to carved stone.

Normally resistant to water penetration, phenolic foam can, however, be made to be readily water absorbent. Blocks of the material, so produced, form highly useful bases for cut flower arrangements. The gaily colored blocks keep the flowers moist and fresh while eliminating the problems of spillage that accompany conventional containers. Water-absorbing foam blocks also make excellent cigar-counter humidifiers. Other specially produced and colored phenolic foams are finding wide acceptance as lightweight decorative material, e.g., in motion picture and stage scenery construction and in retail store window and counter displays.

Syntactic foam

A new concept in foamed plastics was introduced with the development and commercial acceptance of syntactic foam. Hollow, microscopic, phenolic-resin spheres may be bonded together with a polyester, epoxy, or phenolic binder to form a low-density, foam-like material. By choice of binder and, also, by varying the ratio of spheres to binder, a wide range of foam densities can be obtained. One of the more obvious advantages of syntactic foam is that it may be used as a foamed-in-place material without the need for special equipment. Syntactic foam is capable of being utilized in techniques which make possible do-it-yourself applications.[1] The un-

[1] The best sources for information on syntactic foam for do-it-yourself applications are the compounders of this material. Syntactic foam is compounded by: Palmer Products, Inc., Worcester, Pa.; and National Engineering Products, Inc., Washington, D. C.



By carrying out the reactions at high speeds, phenolic resin formulations can be foamed in a vertical wall cavity to controlled heights and with uniform density. As shown above (note clock to left of container), an 8-ft. wall cavity about 4.3 cu. ft. in area can be filled in less than 60 seconds. The foam permanently bonds itself to the wall so it does not sag. (Photo, Bakelite)

cured foam is normally handled as a putty-like mass which can be molded to shape, troweled onto suitable surfaces, forced into cavities, or pressed into sandwich core structures.

The sphere is an ideal engineering structure and the spherical cells of syntactic foam greatly contribute to its strength properties. This spherical cell shape brings to syntactic foam one of the highest strength-to-weight ratios of all plastics foams, along with good insulating qualities. When mixed with the various resin binders, some of which are room-temperature curing, the spheres produce a foam which is also among the most easily handled of plastics foams.

Perhaps the greatest potential for syntactic foam is as a core material in sandwich-type structures. By the use of this controlled-foam technique, flat boards and contoured shapes are produced with equal ease. Syntactic foam materially reduces the flexibility of reinforced plastics with negligible increase in weight. Experimental sandwich structures consisting of cores of phenolic spheres, polyester resin, and loose fibrous glass strands between fibrous glass mats show flexural strengths ranging from 1700 to 4500 p.s.i., tensile strengths between 1600 and 2900 p.s.i., and compressive strengths as high as 12,100 p.s.i.

Syntactic foam is finding expanding use as a core material for such reinforced applications as boat hulls and decks, and reinforced sections of airplane structures.

Syntactic foam also presents a means of applying do-it-yourself techniques to repair of wood structures either in the home or in industry. Rotted-out wood structures can be repaired by troweling the syntactic mixture into the area and letting the putty-like foam cure, or set, until it is hard. The use of epoxy resin —a room-temperature curing material—as the binder in the foam contributes to its ability to cure without special equipment. [illegible]y simple repairs can be eff[illegible]d, and costly structural replace[illegible]ts avoided, with syntactic foam.

Either as a cast materi[illegible] in rotted-out wood structures, [illegible] as a core material in sand[illegible]ich structures, phenolic syn[illegible]tic foam can be easily sawed, pa[illegible]ed, or drilled.

Techniques

Special techniques and formulations have been developed for the foaming of reaction-type phenolic resins and, also, for the preparation of phenolic syntactic foam. In reaction-type phenolic foams, these procedures control the phenol-formaldehyde reaction to yield a uniform, lightweight, resilient material. Syntactic foams which involve no chemical reaction during mixing are prepared by binding together hollow, microscopic phenolic spheres with appropriate formulations either phenolic, epoxy, or polyester resins. Putty-like in consistency, syntactic foams can be used in techniques which make possible do-it-yourself applications. The following suggested formulations and processes have yielded satisfactory results in preparing phenolic foams.

Reaction-type foams

This type foam results from the utilization of the "built-in" heat of reaction of the phenolic resin to cause vaporization of the small amounts of water and solvent present in the mixture of resin and catalyst. During the foaming process, the resin changes rapidly from a free-flowing liquid to an infusible cellular solid. A proper balance of reaction and expansion results in the formation of a foam having a volume as much as 200 times greater than the original liquid resin.

Although the conversion process for making phenolic foam is very simple, involving as it does, the mixing of fluid resin and acid catalyst at room or slightly reduced temperatures, the rapidity of the reaction makes the use of automatic equipment highly desirable, and certain special handling techniques imperative.

In a typical foam formulation, a

wetting agent and isopropyl ether are mixed with the liquid phenolic resins. The isopropyl ether is incorporated into the formulation to yield a finer, better grain in the finished foam. To date, Tween emulsifier No. 40 (Atlas Powder Co.) appears to be the most satisfactory wetting agent.

In actual mixing, the wetting agent is dispersed in the isopropyl ether first and, then, with continuous stirring, this mixture is added to the resin.

A typical catalyst formulation is prepared by adding sulfuric acid very slowly and with continuous stirring, to isopropyl ether. In this operation, the mixing vessel should be immersed in an ice bath or under a reflux condenser.

The temperature should not be allowed to rise over 50° F.

When the sulfuric acid is thoroughly mixed with the isopropyl ether, the catalyst is completed by adding phosphoric acid and thoroughly mixing.

As a cautionary note, it should be realized that these acids are corrosive to skin, metals, woods, etc. Therefore, glass or porcelain vessels should be used and protective goggles or face masks should be worn. Any acid splashed on the skin should be washed away immediately with copious quantities of water. Since the isopropyl ether is highly flammable, as well as somewhat toxic, it should be kept away from sparks and flame; precautions should also be taken so that the user avoids breathing its fumes.

The components are combined and beaten with an agitator. This beating introduces many small air bubbles into the resin. These bubbles serve as "seeds" for the foam formation, and increase the liquid resin volume as much as 20 percent. When the volume of the solution has increased about 20%, the mixture is brought to 77° F., and hardener, also at a temperature of 77° F., is added to the foamable resin.

The mixture is then agitated violently with a propeller-type stirrer for 5 sec. and immediately poured into the foaming container. The material will foam in 7 to 8 sec. after adding the hardener.

Catalyst concentration and temperature of ingredients may be varied to influence the speed of the foaming reaction. Higher-density formulations made with blends of phenolic resins react more slowly than do the low-density formulations.

Although phenolic foam can be produced in any container, it is generally advisable to maintain a slight back pressure on the solution during the exothermic reaction. A simple method of obtaining this back pressure is to invert a container of the desired shape over the foaming pan. As the foam expands, the weight of the container provides sufficient back pressure and the foam uniformly fills the container.

Since the entire operation from the introduction of the acid catalyst to the formation of a fully expanded block of low-density foam is completed in about 45 sec., a cycle controller to initiate automatically the various steps in the process, is highly desirable. The use of such automatic features greatly improves efficiency and uniformity in the production of the reaction-type phenolic foam.

Syntactic foam

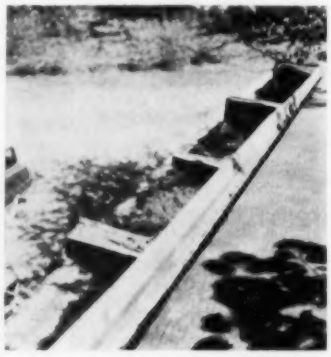
In practice, syntactics are made by combining hollow, microscopic phenolic spheres with either phenolic, epoxy, or polyester resins in much the same way cement and gravel are mixed to form concrete. When bonded with any of these resins, the phenolic balloons produce a foam-like, low-density, cellular composite. Putty-like in consistency, the uncured syntactic foam hardens into a material of high strength and light weight. Foams varying in density from 10 to 40 lb./cu. ft. can be simply and quickly produced by varying the proportion of resin binder to the phenolic spheres.

The following formulations and procedures are typical of various types of syntactic foams:

(POLYESTER BINDER)

Composition	*Parts by weight*
Polyester resin PLL-5000	50
Phenolic spheres BJO-0930	50
Peroxide catalyst	0.5
Cobalt accelerator	0.5

Procedure: Add a weighed amount of polyester resin to the bowl of a kneader-type mixer. With agitation, add the proper amounts of catalyst and accelerator. (*CAUTION:* It is extremely important that they be added separately since combinations of peroxides and cobalt naphthenate are explosively reactive.) Gradually add the phenolic spheres to the mix. After these are added, continue mixing until the components are well-dispersed. The resulting mixture will be a thick, putty-like mass which then may be placed in a suitable mold and cured at room temperature. Temperatures up to 212° F. can be used to accelerate cure. The above formulation produces a foam which has a density of 10.5 lb./cu. foot.



Partially rotted porch beams are repaired with syntactic foam —a mixture of plastic resin and hollow phenolic spheres. (Photo, Bakelite Co.)

(EPOXY BINDER)

Composition	*Parts by weight*
Epoxy resin ERL-2795	30
Epoxy hardener ERL-2793	9
Phenolic spheres BJO-0930	120

Procedure: Add a weighed amount of epoxy resin to a kneader-type mixer. With agitation, add the proper amount of epoxy hardener. Gradually add the phenolic spheres to the mix and continue mixing until a thick, putty-like mass is obtained. This mass may then be hand troweled into place and cured at room temperature. Temperatures up to 212° F. accelerate cure. A foam density of 8.6 lb./cu. ft. results.

Test results indicate that the

upper limit of phenolic spheres which may be used in syntactic foam is 40% by weight or more than 70% by volume. Combinations of phenolic spheres and polyester or epoxy resin can be used to reduce material costs below the costs of the straight resins.

Field experience has shown that the best method of handling putty-like mixes of syntactic foams is with some form of heated trowel. Hot troweling imparts better flow properties to the mixture and makes it easier to form. Heated trowels have been successfully improvised by attaching a standard trowel or other shaped blade to an ordinary household iron or electric soldering iron.

FOAMED SILICONES

BY D. E. WEYER*

Applications

Three ready-to-use silicone powders are available for making heat-stable, rigid foamed structures. Properly foamed and cured, these three powders, Dow Corning R-7001, R-7002, and R-7003, provide foams with a range of physical properties that make them adaptable to a variety of applications, including jet aircraft and guided missiles, as lightweight, stable thermal insulation, or as structural components.

These three, easy-to-handle foam powders offer a number of advantages. Only heat is required to produce expansion—no addition of catalyst or blowing agent is necessary; and, because none of the ingredients are toxic, the need to wear protective masks or gloves during fabrication is virtually eliminated.

Each of the mixes produces a foam with a uniform pore pattern which is predominately spherical and unicellular. Atmospheric pressure and humidity have little effect on their foaming action, and the mold or cavity requires no preheating. The pressure exerted by the foams is practically negligible and the mold can be of light construction. As shown in Table I, p. 357, the density of the foams is determined by the expansion temperature. In many applications the foams may be cured in service.

* Product Engineering Laboratory, Dow Corning Corp., Midland, Mich.

Equal-weight samples of silicone foam and aluminum sheet supporting equal lead weights are exposed to flame. Silicone foam (left) remains rigid and insulates lead from heat. (Photo, Dow Corning Corp.)



Properties of foams

Foamed structures made from these mixes exhibit good physical and electrical properties, low moisture absorption, and are exceptionally heat-stable thermal insulators. (See Table II, p. 357.) Their heat stability is indicated by the fact that samples have been exposed to a temperature of 700° F. for 72 hr. with only slight dimensional change. Total weight loss after this period was less than 10 percent. Similar samples, heated to red heat by direct flame, did not burn and showed only slight surface change.

Both R-7001 and R-7002 can be foamed-in-place between various types of skins. Although R-7003 cannot be foamed-in-place, it is the most rigid of the three at high temperatures and retains the highest order of compressive strength.

At room temperature, foam made from R-7001 has good compressive strength. When exposed to elevated temperatures, however, the foam becomes soft and rubbery without changing appearance. For applications where higher strength at elevated temperatures is desirable, the foamed-in-place assembly can be strengthened through the use of suitable ribbed structures.

This thermoplastic tendency can be applied to advantage in forming the foam to a desired shape before final postcure. After the initial expansion, sections can be cut from the foam and heated again to temperatures around 200° F. At this temperature, the foam softens and it is possible to wrap or form the sections around air ducts, pipes, gasoline tanks, and the like.

Expanded R-7001 is the most resistant to thermal shock. Sample sandwich structures have been cycled between room temperature and 600° F. without cracking. The properties of R-7001 suggest its use in applications where a heat-stable, low-density foam is required, but where high compressive strength at elevated temperatures is not essential.

Although similar to R-7001 in most respects, expanded R-7002 retains a considerable portion of its original strength at temperatures around 500° F. When used as a structural member at elevated temperatures, this foam should be postcured for 48 hr. at 480° F. to increase its high-temperature strength. In other applications the foam will cure and harden during use.

Although R-7003 cannot be foamed-in-place satisfactorily, it is stronger and retains considerably more strength at high temperatures than either of the other two mixes. It is best suited to the production of formed parts. The foam can be cut or carved to almost any desired shape or can be machined to close tolerances.

Sandwich structures can be made by bonding various types of skins to a preshaped block or sheet with adhesives. Appropriate heat-resistant adhesives which may be used effectively for such a sandwich fabrication procedure include Silastic[1] S-2007 and RTV Silastic. Silicone foaming powders will foam-in-place and pro-

[1] Dow Corning silicone rubber.

vide good adhesion to many materials. In some cases, a preliminary surface treatment is advisable (see "Techniques," below).

Limitations

Chief limitation of expanded silicone resins is friability. In many instances this drawback can be greatly reduced with suitable coatings and by foaming-in-place.

The long postcure required for maximum high-temperature strength is also undesirable in some applications. Experimental work on the foams is being directed toward minimizing both limitations along with producing lower-density foams for economical reasons.

The heat resistance of expanded silicone resins, coupled with their low thermal conductivity, suggest a broad potential in the field of high-temperature thermal insulation. At present, principal interest in the silicone foams centers about their use as a foamed-in-place sandwich core for jet aircraft and guided missiles.

Techniques

Dow Corning silicone foaming powders can be foamed to yield heat-resistant structures varying in density from 10 to 18 lb./cu. foot. Expansion takes place at moderately low temperatures ranging from 300 to 350° F.; therefore, no special heating equipment is required. Expansion can be accomplished in a circulating air oven, with strip heaters, heat lamps, or other similar heating devices. In applications where the silicone foams are used as thermal insulation, they can be cured in service.

Procedure

Surface preparation: The silicone foaming powders will foam-in-place and provide good adhesion to asbestos paper and board, glass, ceramic, and silicone laminates without the need of special surface preparation.

Where adhesion to smooth cavity walls is of prime importance, however, a preliminary surface treatment is advisable. The smooth wall should be sanded lightly to remove gloss, and then coated with Dow Corning 994 Varnish which can be applied with a paint brush or spray gun. Heating for 5 to 10 min. at 320° F. drives off the solvent, and leaves a coating that is slightly tacky until it is cured in contact with the foam.

For casting blocks or sheets, the mold form or container is lined with metal foil or heat-resistant cellophane. After expansion, the foamed blocks or sheets can easily be removed from the form, and the foil or cellophane stripped off.

Blocks or sheets can also be cast directly in mold forms, provided the form surface has been properly treated with an effective release agent for rigid silicone foam structures, e.g., Dow Corning C-4182. Its use on cavity walls results in silicone foams with smooth glossy skins which reduce friability. Easily applied by wiping a thin coating onto clean surfaces, Dow Corning C-4182 gives best results if heated for 5 to 10 min. at 300 to 350° F. to drive off solvent and to effect cure.

Expanding and curing: The required quantity of foamable powder can be poured into any opening at the top of the cavity. If the cavity walls are thin and a close dimensional tolerance is desired, outside supporting molds are suggested. One-quarter inch aluminum plates are satisfactory. These molds do not have to be preheated.

After clamping the assembly, heat may then be applied by means of an air-circulating oven, heat lamp, or strip heater to produce the foam.

Foam density obtainable is determined by the expansion temperature. Table I, above, gives typical densities obtainable at the

TABLE I: Effect of foaming temperature on density of silicone foams

Expansion temperature	*Density*		
	R-7001	*R-7002*	*R-7003*
°F	lb./ft.³	lb./ft.³	lb./ft.³
300	14	16	19
320	12	14	16
340	11	13	15
355	10	12	14

TABLE II: Typical properties of silicone foams

Property	*Open pan foam made from*		
	R-7001	*R-7002*	*R-7003*
Expansion temperature, °F.	320	320	320
Density, lb./cu. ft.	12	14	16
Cell size, in. diameter, less than	0.08	0.08	0.08
Compressive strength			
at 77°F., p.s.i.	100	200	325
at 77°F., after 200 hr. at 500°F., p.s.i.	100	190	210
at 500°F., after ½ hr. at 500°F., p.s.i.	5	25	70
at 500°F., after 200 hr. at 500°F., p.s.i.	20	45	80
Weight loss			
during expansion, %	1.2	1.3	1.0
after 1000 hr. at 500°F., %	3.5	2.6	2.6
after 1000 hr. at 570°F., %	8.0	4.2	4.2
after 72 hr. at 700°F., %	8.5	5.2	5.2
Water absorption after 24 hr. immersion, % by weight	3.2	2.3	2.1
Heat distortion temperature, °F.	>700	>700	>700
Flame resistance	—Do not burn—		
Dielectric constant at 10^5 cycles	1.23	1.25	1.26
Power factor at 10^5 cycles	0.0004	0.00102	0.00105
Thermal conductivity, B.t.u./hr./sq. ft./°F./in. thickness	0.3	0.3	0.3

various expansion temperatures. The size and shape of the cavity also slightly affect the density of the foam.

The time required for the powder to melt and expand to maximum height is about 2 hours. To insure against shrinkage, however, the structure should be held at the expansion temperature for at least 4 hours. Foamed pieces made up in forms coated with C-4182 can be removed from the form at this point and cured. Mold forms are thereby made available to accommodate another load of foaming powder.

In most applications where the silicone foam is to be used as a thermal insulator, no postcure is necessary because the foam will cure and become hard during use. To develop good room-temperature and high-temperature compressive strength, a postcure of 24 to 48 hr. at 480° F. is recommended. The curing oven temperature should be raised gradually to 480° F. in increments of 25° F./hr., held at 480° F. for 24 hr., and then cooled to room temperature over a period of approximately 4 hours.

Quantity determination: The weight of silicone foaming powder normally required to fill various-size cavities at different expanding temperatures can be determined by means of a simple ratio as follows:

$$\text{Pounds foaming powder required} = \frac{\text{Cavity volume, cu. in.} \times \text{Foam density at expansion temp.}}{1728}$$

or:

$$\text{Pounds foaming powder required} = \text{Cavity volume, cu. in.} \times \text{Foam density at expansion temp.}$$

For a more uniform cell structure, about 10% excess powder should be added to the cavity to assure an overflow.

FOAMED EPOXIES

Epoxy resins can be converted into foamed or expanded plastics which are suitable for many applications, e.g., encapsulation of electronic components, thermal insulation, and as core materials in sandwich-type structures for rigid flooring, bulkheads, doors, etc.

Two-component liquid systems and single-component epoxy foaming resins are available. In both types, a chemical blowing agent must be included in the formulation, as well as the curative. The blowing agent is responsible for liberation of the gas which produces the expansion of the resin. Wetting agents also are frequently included. When necessary, a volatile liquid may be added in order to absorb some of the exothermic heat.

Two-component liquid systems are available which have relatively short working lives. Heat is essential to induce foaming and may be supplied externally or result from the exothermic heat of the curing reaction. When potting delicate components, or if a very uniform cell structure is desired, high exotherms must be avoided. Additional heat-curing generally is recommended after the foaming operation. An excellent foamed cell structure has been reported for an epoxy-polyamide system, which can be prepared with external heating, using dimethyldinitrosoterephthalamide as the blowing agent.

Single component epoxy foaming resins, in powder form, have extended storage lives.

Prefoamed blocks

More recently, a manufacturer[1] has announced the availability of prefoamed blocks of epoxy resin. The blocks are made by simultaneously foaming and curing an epoxy resin formulation under very carefully controlled conditions.

Since the end product is thermoset, it is unaffected by solvents and has a temperature resistance expected of cured epoxy resin. It is classified as a rigid foam and is readily machinable by ordinary woodworking tools. Because of its fine, uniform structure and complete freedom from grain, it may be carved or machined with great ease, leaving a good surface on which finishing coats may be applied. It has exceptionally good dimensional stability and pieces made from the foam show complete freedom from warping and excessive dimensional changes on exposure to moderately elevated temperatures and high humidity. The core structure is essentially unicellular and therefore the material lends itself well to flotation applications.

Large foam blocks available in sizes up to 1 by 2 by 6 ft. are finding particular utility in tool rooms where they are excellent basic materials for templets, check fixtures, and models. Another suggested application is the making of building panels in which the sheets of foam are covered on one or both sides with decorative skins, using either polyester resins or epoxy resins.

[1] D & R Pilot Plants, Inc., Hazardville, Conn.

References

Consult the Subject Index for additional information concerning foamed plastics and foaming agents. See also the Foamed Plastics Chart for information on properties and trade designations. For sources of foamed plastics, see Directory Index, p. 1018.

"Foam in a hi-fi speaker," MODERN PLASTICS *34*, 122 (Sept. 1956).

"Mechanical action of flexible foams," by R. H. Carey and E. A. Rogers, MODERN PLASTICS *33*, 139 (Aug. 1956).

"Market view of vinyl foam," MODERN PLASTICS *33*, 113 (May 1956).

"Balsa core for reinforced plastics structures," by R. Mark, MODERN PLASTICS *33*, 131 (May 1956).

"Fabrication methods for expandable polystyrene," by G. E. Franson, Plastics Tech. *2*, 452 (July 1956).

"Designing with vinyl foam," by R. Wistozky, Plastics Tech. *2*, 443 (July 1956).

"Plastic foams—their relationship and competitive picture," by J. J. Hirsch, Plastics Tech *2*, 377 (June 1956).

"From jets to jewels," by B. L. Raskin, Chem Eng. News *34*, 2492 (May 21, 1956).

"Many plastics foams under development," Brit. Plastics *29*, 118 (Apr. 1956).

"Continuous production of vinyl foam," Brit. Plastics *29*, 86 (Mar. 1956).

Foaming Agents

BY D. J. MASSEY*

The use of foaming agents to produce cellular plastics and rubber products has expanded greatly in the last few years. The variability and uniqueness of properties that may be obtained have allowed manufacturers to produce products of great utility in diverse forms. The general area of cellular products has two major classifications. One is discrete or unicellular material, and the other is continuous or interconnecting cellular material. The unicellular products are generally made from organic blowing agents which, upon decomposition, produce nitrogen. Continuous cellular foams may be made by the use of carbon dioxide (free or from carbonates) or other gases.

Cellular polymers can be made principally by five methods: 1) incorporating a chemical "blowing agent" into a resin or rubber mix to form a gas by chemical reaction induced by heat; 2) incorporating a specific bifunctional compound (i.e., a diisocyanate) into a polyester which reacts to liberate a gas and also to cross-link the resulting foam into a rigid or flexible structure; 3) whipping air into a colloidal resin or rubber suspension and gelling the porous mass, e.g., foamed latex; 4) injecting a gas into a partially vulcanized rubber or resin mix under high pressure in an autoclave; and 5) incorporating a nonchemical gas-liberating agent into a rubber or resin mix which, when heated, releases a gas (i.e., a gas adsorbed on a finely divided solid).

Although all five methods are of commercial importance, only the first two use chemical foaming or blowing agents.

Blowing agents

Blowing agents are chemical additives for plastics and rubber that decompose on heating, yielding gases which produce lightweight cellular products. Several inorganic compounds (e.g., sodium and ammonium bicarbonate, sodium nitrate, ammonium nitrite) have been used for many years as a cheap source of gas for manufacturing sponge rubber. Unlike with the inorganic compounds, use of an organic blowing agent has the advantage that the temperature at which gases are evolved can be closely controlled, and therefore the process of producing evolved gases can be regulated. Organic blowing agents also produce gas under pressure and can develop great effectiveness with relatively small quantities.

Considerable patent activity has been observed for the last year or two, revealing active interest in the development of new blowing agents. None of the compounds revealed have been commercialized. Table I, p 360, summarizes the more important commercial products.

The blowing agent is generally incorporated into the resin via fine grinding with a plastisol. If the plasticizer concentration in the plastisol is too low for proper dispersion or if dry rubber is used, direct milling may be employed provided the stock can be kept below the decomposition range of the blowing agent. The resin or rubber mix containing the blowing agent is transferred to appropriate molds for heating and/or vulcanizing. A two-stage heating cycle is often used with polyvinyl chloride—the compounded plastisol is heated above the decomposition temperature and then cooled to room temperature. The cooled, partially expanded article is removed from the mold and further heated at a critical temperature to attain the desired expansion without deforming the article.

Although expanded rubbers may be highly filled, use of fillers in plastics compositions sometimes becomes complicated because of their adverse effect upon the chemical that serves to supply the gas which acts as the foaming or blowing agent.

For unicellular rubbers, 5 to 10 parts blowing agent per 100 parts of rubber hydrocarbon are used; for unicellular vinyl, the amount varies between 10 and 20 parts per 100 parts of resin.

Bifunctional compound

The second major technique, using the reaction of a specific bifunctional compound with a polyester to liberate a gas, is exemplified in the manufacture of urethane or isocyanate foam.

In a broad sense, the use of isocyanates follows the blowing agent concept with the diisocyanate providing the source of the gas (carbon dioxide) as well as the cross-linking medium. The chemistry of the isocyanate foams is concerned principally with the reactions of isocyanates with three types of compounds (alcohols, water, and carboxylic acids) as shown in the following three equations:

$$RNCO + R'OH \rightarrow RNHCOOR' \quad (1)$$

$$2RNCO + H_2O \rightarrow RNHCONHR + CO_2 \quad (2)$$

$$RNCO + R'COOH \rightarrow RNHCOR' + CO_2 \quad (3)$$

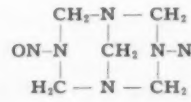
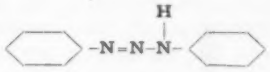
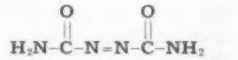
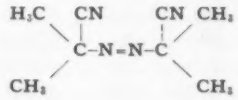
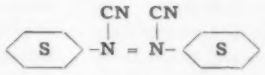
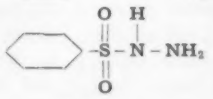
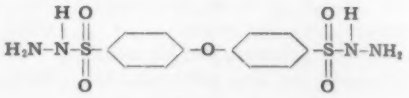
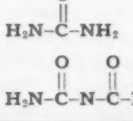
The first reaction is of primary importance in cross-linking reactions, while the second and third reactions serve to generate gas for foaming, as well as cross-linking.

In the preparation of foams, tolylene diisocyanate is used in conjunction with a liquid or low-melting polymer containing reactive groups such as hydroxyl and carboxyl groups. The polymer most frequently used is a polyester. For rigid foams a highly branched polyester is used, while for flexible foams a polyester having only a little branching is preferred.

If the polyester used has a high acid number, reaction of the isocyanate with the carboxyl groups generates the gas for foaming. When polyesters of low acid number are used, 1 to 2% of water is added to decompose the excess isocyanate and thus produce carbon dioxide gas. A tertiary amine

* Project Specialist, Rubber Chemicals Section, Development Dept., Monsanto Chemical Co., Organic Chemicals Div., Nitro, W.Va.
References were prepared by the editors.

TABLE I: Principal commercial organic blowing agents

Trade name	*Manufacturer*	*Active compound*	*Structure*
Nitroso compounds			
Unicel ND Vulcasel BN	DuPont ICI	N, N'-Dinitrosopentamethylenetetramine	
Azo compounds			
Unicel Porofor DB Vulcasel AN	DuPont Bayer ICI	Diazoaminobenzene (1,3-diphenyltriazene)	
Celogen AZ Porofor 505-A	Naugatuck Bayer	Azo-dicarbonamide (1,1'-azobis-formamide)	
Porofor N	Bayer	2,2'-Azo-isobutyronitrile	
Porofor 254	Bayer	Azo-hexahydrobenzonitrile	
Hydrazides			
Porofor BSH	Bayer	Benzene sulfonylhydrazide	
Celogen	Naugatuck	*p,p'*-Oxy-bis-benzenesulfonylhydrazide	
Azide			
Wingcel S	Goodyear	*p-tert*-Butylbenzoylazide	
Mixture			
Blowing Agent 1475	Sherwin-Williams	Mixture of urea and biuret	

may be used as a catalyst, and an emulsifier may be added as a means of assisting the mixing action.

In the operation, all ingredients may be mixed at one time, using good agitation. Just as the evolution of gas begins, the liquid mixture is poured into the mold or cavity to be filled and the foaming reaction proceeds without the application of heat or pressure. The best physical properties are obtained, however, if a short cure at 70 to 125° C. is used. The foaming recipe must be carefully adjusted to provide gas evolution at a suitable rate and before gelation occurs.

The density of the foam is regulated by controlling the extent of the reaction between isocyanate and water or carboxylic acid. The time and degree of mixing the ingredients must be carefully controlled. The preparation of flexible foam requires 15 to 40 parts of diisocyanate per 100 parts of polyester, while rigid foams usually require 60 to 100 parts of diisocyanate.

References

Consult the Subject Index for additional information concerning foamed plastics. See also the chapter on Foamed Plastics, p. 334, and the Foamed Plastics Chart. For sources, see the Directory Index, p. 1018.

"Mechanical action of flexible foams," by R. H. Carey and E. A. Rogers, MODERN PLASTICS *33*, 139 (Aug. 1956).

"Styrene foam float and life preserver ring," MODERN PLASTICS *33*, 219 (Apr. 1956).

"PVC pastes—theory and practice. I. Paste formulation," by M. S. Welling, Plastics (London) *21*, 121 (June); "II. Coating, embossing, open-cell foaming," Plastics *21*, 161 (July); "III. Closed-cell foaming, dipping, slush-molding," Plastics *21*, 194 (Aug. 1956).

"Cellular PVC," by S. E. Bolam and M. S. Welling, Rubber and Plastics Age *37*, 379 (June 1956).

"Manufacture of polyurethane foams," Canadian Plastics *1955*, 44 (Dec.).

"Foamed in the mold," Modern Packaging *29*, 116 (Sept. 1955).

How to make Vinyl Foam without special equipment...

Use Du Pont BL-353 Blowing Agent

To stimulate your inventive mind, here are just a few typical examples of the wide variety of products being made from vinyl expanded with Du Pont BL-353.

Du Pont BL-353 is a chemical blowing agent. For ability to produce expanded vinyl with a wide range of physical properties it has no equal. Here are a few of the many advantages you can derive from using this general purpose blowing agent:

No Special Equipment

With Du Pont BL-353, low density vinyl foam can be made at atmospheric pressure without any special equipment.

Can also produce Cellular Vinyl

BL-353 is equally well suited for producing cellular vinyl, in which, unlike vinyl foam, the cells are not interconnected.

Wide Range of Properties

With only slight variations in the formulations and processing conditions, vinyl foam or cellular vinyl can be obtained in a wide range of physical properties—from rigid to soft and resilient, and in densities ranging from 2.5 to 35 lbs. per cu. ft.

Uniform Cell Structure

BL-353 produces vinyl foam and cellular vinyl with fine, uniform cells in either thick or thin sections. With dielectric heat for fusion and curing, vinyl foam slabs up to 6 inches in thickness can easily be produced.

Variety of Colors

Foam in a variety of colors (including snowy white) can be made with BL-353 because it imparts no color or odor to the resin.



CELLULAR VINYL OR VINYL FOAM—Both types of expanded vinyl can be made with Du Pont BL-353. Pictured above, approximately 1/12 actual size, are products made of both types in a wide range of physical properties. The slab cushion, fish net floats and boat fender are of cellular vinyl (all by Linen Thread Co.). The thin sheet and belt (Crest Chemical Industries Corp.) and the two children's toys are made of vinyl foam. The shoe soles (Foam King, Inc.) are made of both cellular vinyl and vinyl foam.

WRITE FOR BULLETINS, SAMPLE

Two bulletins which give complete data on BL-353 from chemical composition to uses and availability, are yours for the asking. Ask for a sample too, for testing in your own production equipment. Write to E. I. du Pont de Nemours & Co., Inc., Chemical Sales, Explosives Dept. MPE, 2543 Nemours Bldg., Wilmington 98, Del.

DU PONT BL-353

CHEMICAL BLOWING AGENT

DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

DEVILBISS

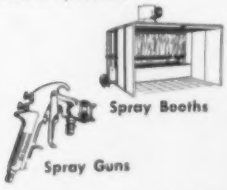
CATALYST SPRAY EQUIPMENT

(Eliminates pre-mix and pot-life problems)

When your spray requirements call for a simplified, efficient application of catalyzed foams or coatings:

polyester laminates • epoxies • iso-foams (urethane and polyethers) • converted varnish • wash primers (zinc chromates)

look to DeVilbiss for a complete line of spray equipment, technical experience, and research facilities. DeVilbiss engineers will be glad to analyze your application problems. Write the DeVilbiss Company, 290 Phillips Avenue, Toledo 1, Ohio.



Spray Booths

Spray Guns



Air Compressors



Hose and Connections

Air and Fluid Regulators | Paint Heaters and Material Tanks | Respirators and Hoods | Complete Finishing Systems



New DeVilbiss High-Volume Catalyst Spray Gun—Model P-JGC-504

THE DEVILBISS COMPANY, Toledo 1, Ohio

Barrie, Ontario • London, England

Branch Offices in Principal Cities

FOR BETTER SERVICE, BUY DEVILBISS

MOLDED FOAM STYRENE

Ambassador Plastics & Manufacturing Corporation, America's most experienced custom molder of foam styrene—specializing in high volume automatic production and precision molding.

Experience in molding foam styrene insulation, packaging, displays, flotation devices, decorations and toys. Facilities include complete mold making shop, finishing and decorating equipment, complete staff of engineers—including packaging engineers.

Special techniques: hard surface, molding in color, extremely low density, thin sections and bonding to polyester glass and other materials.

APM

AMBASSADOR PLASTICS & MFG. CORP.

310 W. Erie St., Chicago 10, Ill.

WHitehall 3-0171

Additional copies of the famous, authoritative Plastics Properties Chart available to subscribers in limited quantities

Order now . . . don't delay!

This clearly printed, wall-size chart contains essential data on the physical, chemical, thermal, electrical, and molding characteristics of all commercially available thermoplastics and thermosetting plastics. The identical chart is included with this copy of the Encyclopedia.

While the charts last, they are available at $1.00 each.

No COD's. Cash or check with order, please.

Industrial Magazine Service, Inc.

575 Madison Avenue New York 22, N. Y.

Advertisers' Index

CHEMICALS FOR PLASTICS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 364

ALCOHOLS FOR PLASTICIZERS

Enjay Company, Inc. 403-406
Wallace & Tiernan, Inc., Harchem Div. 419

CATALYSTS

McKesson & Robbins, Inc. 430
Pittsburgh Coke & Chemical Co., Industrial Chemical Div. 423-426
Wallace & Tiernan, Inc., Lucidol Div. 418

COLORANTS, DYES, PIGMENTS, INKS

Acheson Dispersed Pigments Co. 417
Allied Chemical & Dye Corp., National Aniline Div. 398-399
American Cyanamid Company, Dyes Dept. 388
American Cyanamid Company, Pigments Div. 389
Cabot, Godfrey L., Inc. 397
Claremont Pigment Dispersion Corp. 415
Columbian Carbon Company 407
Drakenfeld, B. F., & Company, Inc. 420
Ferro Corporation, Color Div. 393
General Dyestuff Company, Div. General Aniline & Film Corp. 400
Glidden Co., The, Chemicals-Pigments-Metals Div. 428
Harshaw Chemical Company, The 410-411
Harwick Standard Chemical Co. 390
Hommel, O., Co., The, Pigment Div. 402
Kentucky Color & Chemical Company, Inc. 395
Krieger Color & Chemical Co., Inc. 420
Plastics Color Company 429
Plastic Molders Supply Co., Inc. 392
Reed Plastics Corporation 412
Riverdale Color Co., Inc. 427
Witco Chemical Company 391

FILLERS

Cabot, Godfrey L., Inc. 397
Witco Chemical Company 391

FORMALDEHYDE

Du Pont de Nemours, E. I. & Co., Inc., Electro Chemicals Dept. 396
Celanese Corporation of America, Chemical Div. .. 408-409
Merck & Co., Inc. 400

MOLD LUBRICANTS

Borco Chemicals Inc. 422

ORGANIC PEROXIDES

McKesson & Robbins, Inc. 430
Wallace & Tiernan, Inc., Lucidol Div. 418

PEARL ESSENCE

Mearl Corporation, The 392
Rona Laboratories, Inc. 413

PLASTICIZERS

Allied Chemical & Dye Corp., Barrett Div. 416
Archer-Daniels-Midland 395
Argus Chemical Corporation 431
Brown-Allen Chemicals, Inc. 400
Celanese Corporation of America, Chemical Div. .. 408-409
Chemische Werke Huls Aktiengesellschaft 402-A
Columbian Carbon Company 407
Deecy Products Company 420
Emery Industries, Inc. 421
Harwick Standard Chemical Co. 390
Pittsburgh Coke & Chemical Co., Industrial Chemical Div. 423-426
Rubber Corporation of America 418
Wallace & Tiernan, Inc., Harchem Division 419
Witco Chemical Company 391

RAW MATERIALS

Advance Solvents & Chemical Div., Carlisle Chemical Works, Inc. 414
Allied Chemical & Dye Corp., National Aniline Div. 398-399
Badische Anil- & Soda-Fabrik AG. 402-B
Celanese Corporation of America, Chemical Div. .. 408-409
Chemische Werke Huls Aktiengesellschaft 402-A
Enjay Company, Inc. 403-406
Industrial Solvents & Chemicals, Inc. 430
Pittsburgh Coke & Chemical Co., Industrial Chemical Div. 423-426
Rubber Corporation of America 418

RESINS

Diamond Alkali Company, Chlorowax Division 401

RELEASE AGENTS

Fine Organics, Inc. 413

SOLVENTS

Allied Chemical & Dye Corp., National Aniline Div. 398-399

STABILIZERS

Advance Solvents & Chemical Div., Carlisle Chemical Works, Inc. 414
Antara Chemicals, Div. General Aniline & Film Corp. .. 395
Argus Chemical Corporation 431
Deecy Products Company 420
Harwick Standard Chemical Co. 390
Metal & Thermit Corporation 432
Synthetic Products Company 422
Witco Chemical Company 391

STEARATES

Witco Chemical Company 391

Chemicals for Plastics

Organic Intermediates

Broadly speaking, the basic raw materials used in the synthesis of commercial plastics are: salt, sulfur, lime, air, water, coal, petroleum, and cellulose.

Salt: Electrolysis of salt in water solution yields chlorine, sodium hydroxide, and hydrogen. Hydrochloric acid is produced by burning chlorine in the presence of hydrogen.

Sulfur: Sulfuric acid is obtained by the catalytic oxidation of sulfur dioxide, produced by burning sulfur in air to sulfur trioxide, which with water yields sulfuric acid. This and other inorganic compounds of sulfur are used to produce a large variety of resins and plasticizers.

Lime: Lime is calcium oxide which is prepared by removing carbon dioxide from limestone (calcium carbonate) by heating (calcining). Its significance to the plastics industry lies in its reaction with coke at a temperature of about 3600° F. to yield calcium carbide, which is used for the manufacture of acetylene.

Air: Oxygen and nitrogen are available in inexhaustible quantities in the atmosphere. The former is used directly in oxidation processes or may be obtained in concentrated form by fractionation of liquefied air. Nitrogen from air is the chief source of ammonia and nitric acid.

Water: Water serves as the primary industrial source of hydrogen used in the manufacture of hydrochloric acid, ammonia, and hydrogenated products. Methyl alcohol is formed by treatment of a mixture of hydrogen and carbon monoxide. Partial oxidation of this alcohol with air yields formaldehyde, an important chemical in resin manufacture. Water is an essential raw material in the synthesis of acetylene from calcium carbide. Water is further reacted with acetylene to form acetaldehyde.

Chemicals from coal

Large quantities of bituminous coal are carbonized in chemical-recovery coke ovens to make coke and "coal chemicals." Economically, the principal product is coke, most of which is consumed in the blast furnaces of the steel industry to convert iron ore into pig iron. As a result of this economic condition, production of coal chemicals is largely geared to demand for steel, and not to demand for the chemicals by the plastics industry and other consumers of these products. Despite this limitation, huge quantities of coal chemicals and their derivatives are used in the manufacture of plastics.

For the plastics industry the coal chemicals that are by far the most important are benzene and naphthalene. Benzene is the prime chemical used for synthesis of phenol, which is chiefly consumed in making phenolic resins. Benzene is also used in equally large quantities for the synthesis of styrene, the monomer for production of polystyrene. Maleic anhydride and other intermediates also are synthesized from benzene. The largest use for the naphthalene from chemical-recovery coke ovens is its controlled oxidation to phthalic anhydride, used in large quantities for the manufacture of alkyd resins and plasticizers. Until recent years benzene came exclusively from the carbonization of coal, but the limitations mentioned above have led to some supplementary production from petroleum during the last few years. Coal carbonization is still the only commercial source of naphthalene.

Among the other chemicals recovered from the tar and the light oil of coke-oven plants are cresol and other tar acids used in making certain types of phenolic resins, and toluene, xylene, coumarone, and indene, all of which find use in manufacture of some plastics and resins.

The hydrogenation of coal is a potential source of the same types of chemicals now recovered from coal-carbonization plants. Although this process has not yet attained full-scale commercial use, it is a promising future sup-

Isobutyronitrile (Eastman Chemical Products, Inc.), derived from isobutyraldehyde, is now available in commercial quantities. This short, compact molecule has a reactive nitrile group available for various additions. Thermal cracking, selective oxidation, or dehydrogenation produce methacrylonitrile.

Alpha-olefins derived from fatty alcohols (Chemical Products Div., Archer - Daniels - Midland Co.) are almost colorless, odorless liquids at room temperature, with unusual reactivity and good solubility characteristics.

Two novel epoxy compounds, dipentene monoxide and alpha-pinene oxide (Becco Chemical Div., Food Machinery and Chemical Corp.), are suggested for use as intermediates in the manufacture of plasticizers, protective coatings, insecticides, bactericides, lubricant additives, adhesives, flotation agents, perfumes, flavorings, and pharmaceuticals; as reactants in organic synthesis; and as solvents.

A hydrocarbon oxidation process (Scientific Design Co., Inc.), by which a variety of aromatics are produced from para-diisopropylbenzene by air oxidation, will be used to manufacture phthalic anhydride, isophthalic acid, terephthalic acid, dimethyl terephthalate, dimethyl isophthalate, and benzoic acid (Standard Oil of Indiana).

Methallyl chloride (Organic Chemicals Div., Food Machinery and Chemical Corp.) can be self-polymerized or copolymerized with a wide variety of reactive monomers.

Triallyl citrate (Chas. Pfizer and Co., Inc.), a new industrial chemical, is particularly useful in the plastics industry as a cross-linking agent for polyester resins. It can be polymerized to hard, brittle thermoset polymers.

A new chemical building block, glycidyl methacrylate (*GMA,* Du Pont Finishes Div.), offers a convenient way of introducing epoxide groups into vinyl polymers or, conversely, vinyl groups into condensation polymers. The monomer will polymerize thermally, with ultra-violet light, or with the usual free radical or ionic polymerization catalysts.

A pure form of *d*-limonene, used in the production of synthetic terpene chemicals and resins, is now offered in tank-car quantities (Florida Molasses Corp.); *d*-limonene is the main constituent of orange and grapefruit oil and is recovered as a by-product in the manufacture of citrus pulp and molasses.

An acetal resin (*Delrin,* Du Pont), made by the polymerization of formaldehyde, has an excellent combination of high tensile strength, toughness, high melting temperature, good fatigue life, dimensional stability, solvent resistance, and resistance to deformation.

A new saturated fatty alcohol (*Adol 45,* Chemical Products Div., Archer-Daniels-Midland Co.) is a long-chain diol with a high melting point of 69° C. It is a practically odorless hydroxy stearyl alcohol derived from hydrogenated castor oil.

Commercial production of pure-grade flake trimethylolpropane (Chemical Div., Celanese Corp. of America) at a lower price makes possible economical use of this high-quality aldol product in a number of basic processing areas. Trimethylolpropane is an important component in production of polyurethane and alkyd resins.

Two chemical products of pine gum, developed by U.S. Department of Agriculture scientists, are now available commercially. The first, maleopimaric acid (Eastman Kodak Co., Distillation Products Div.), has applications in products requiring a plasticizer, emulsifier, or resin. The other, pinane hydroperoxide (American Cyanamid Co.), is a catalyst with applications in the production of certain plastics.

Four silicon chemical intermediates (*Organo-Functional Silanes,* Silicones Div., Union Carbide Corp.) can be reacted with organic chemicals as organic chemicals. They are useful in the modification of ingredients of emulsifiers, antistatic agents, sizing and finishing agents, synthetic resins, and others.

Four reactive, unsaturated monomers (Ohio-Apex Div. of Food Machinery and Chemical Corp.) are capable of being polymerized into hard, infusible resins. Three of the materials (diallyl adipate, diallyl diglycollate, and diallyl isophthalate) are difunctional; the fourth (diallyl maleate) is trifunctional. These monomers are suggested as cross-linking agents for all types of reinforced plastics operations.

Surface-active lignin sulfonate (*Orzans,* Crown Zellerbach Corp.) precipitate readily from solutions and cling to fibers or other materials present. The product is used as a binder for fibers, retention of fines, an emulsifier, an emulsion stabilizer, a flocculant, a dispersant, an extender in polyvinyl adhesive, and as an ingredient and extender in phenolic resins.

Titanium trichloride (Stauffer Chemical Co.), used as a catalyst in the production of polyolefins, is now available in quantities ranging up to hundreds of pounds. The material, which is a dark purple powder with a density of 7 to 30 lb./cu. ft., is soluble in water, ethyl alcohol, and acid solutions and insoluble in ethyl ether and organic solvents.

A new polyester resin incorporating isophthalic (Oronite Chemical Co., subsidiary Standard Oil Co. of Calif.), it is claimed, can be diluted with 10 to 15% more styrene than when using phthalic anhydride and still retain the same level of strength properties.

plementary source of coal chemicals for use in segments of the plastics industry.

Coke finds some important uses in making chemicals for plastics manufacture. When coke and lime (secured from limestone) are heated to a high temperature, calcium carbide results and from this material is obtained acetylene, an important building block for vinyl resins and acrylonitrile. Melamine may also be produced from calcium carbide by a series of chemical operations involving cyanamide.

Coke is also gasified by steam in the water-gas process to make a mixture of hydrogen and carbon monoxide, which may then be catalytically converted into methanol, ammonia, or urea. Controlled oxidation of the methanol yields formaldehyde, an important chemical used in manufacture of resins. Until recent years coke was the sole source of these chemicals but, as is pointed out below, natural gas is now also being used as a raw material.

Petroleum and natural gas

Chemicals derived from these raw materials have recently been called "petrochemicals." The growth of the petrochemical industry has been very rapid and today some of the most useful chemical building blocks for the manufacture of plastics come almost entirely from this source.

The most important of the petrochemicals are the aliphatics, and all but a small percentage of aliphatic chemicals produced in the United States originate in petroleum or natural gas. Ethylene is undoubtedly the most versatile and useful of the aliphatic building blocks used in production of plastics, since it is the monomer of polyethylene. It is used along with benzene to make styrene, and also enters into the synthesis of vinyl chloride and ethylene oxide. Originally, ethylene was recovered from refinery gases as such, but demand has been so very great that now it is largely produced from light hydrocarbons by thermal cracking. Propylene, obtained by similar methods, leads to production of isopropyl alcohol, acetone, and thence methyl methacrylate, also to propylene oxide and other chemicals. *n*-Butylene by dehydrogenation is converted into butadiene.

Natural gas has now largely displaced coke as the raw material for production of the synthesis gas from which ammonia, urea, and methanol are manufactured. As stated before, methanol is the product from which formaldehyde, an important plastics chemical, is produced. In addition to the calcium carbide source mentioned, substantial quantities of acetylene are being made today by controlled cracking.

The aromatic petrochemicals have come along only within the last few years to supplement the supply that for a long period came exclusively from carbonization of coal. Production from petroleum sources is very largely toluene and xylenes, whereas the light oil from coke ovens is predominantly benzene. These aromatic hydrocarbons are obtained by the catalytic reforming of certain petroleum distillates. The petroleum aromatics find much the same uses in the plastics industry as those from coal. One distinctive adaptation, however, is the manufacture of phthalic anhydride by the controlled oxidation of orthoxylene in place of naphthalene.

Probably the most useful agricultural product used by the plastics industry is cellulose, usually obtained from wood or cotton.

When cellulose is reacted with various chemicals, cellulosic plastics are produced. Ethyl alcohol, from which ethylene may be obtained, is produced by fermentation of grain or other plant products. Furfural, from which furan resins are made, is obtained from corncobs, oat hulls, and other farm products. Glycerol, obtained by the hydrolysis of fats and oils, is used in manufacture of alkyd resins. Agricultural products, although having very diverse applications in the plastics industry, constitute a relatively small proportion of the raw materials in comparison with the large contributions from coal, petroleum, and natural gas.

Solvents as intermediates

Many solvents produced from the raw materials described above find use as intermediates for the preparation of other organic chemicals. Solvents can be used directly in resin manufacture, e.g., methanol used for methylated urea textile resins, propanol used for propylated urea coating resins, etc. They can also be used for the preparation of plasticizers, e.g., *n*-butanol used for butyl esters (phthalates), ethylene glycol used for polymeric plasticizers, ethanol used for ethyl esters (phthalates), methanol used for methyl esters (phthalates), etc.

Finally, solvents can be used to prepare resin intermediates. As an example, methanol is used in the preparation of formaldehyde which in turn is used in the manufacture of phenolic, urea, and melamine resins. Another example is ethanol used to make the acetaldehyde and pentaerythritol that goes into the manufacturing process used to make the alkyd resins.

References

Consult the Subject Index for additional information concerning chemicals for plastics. For sources of chemicals, see Directory Index p. 1018.

"Glycidyl ether reactions with alcohols, phenols, carboxylic acids, and acid anhydrides," by L. Schechter and J. Wynstra, Ind. Eng. Chem. *48*, 86 (Jan. 1956).

"Glycidyl ether reactions with amines," by L. Schechter, J. Wynstra, and R. P. Kurkjy, Ind. Eng. Chem. *48*, 94 (Jan. 1956).

"Intermediate for flame-resistant polymers," by W. A. Reeves and J. D. Guthrie, Ind. Eng. Chem. *48*, 64 (Jan. 1956).

"Incorporation of aroyloxy radicals in polymer molecules," by R. L. Dannley and E. L. Kay, J. Polymer Sci. *19*, 87 (Jan. 1956).

"Aromatics in fibers and films," by G. P. Hoff and J. L. Martin, Ind. Eng. Chem. *47*, 2122 (Oct. 1955).

"Monomeric Acrylic Esters," by E. H. Riddle. 1954. New York: Reinhold Publishing Corp.

"Formaldehyde," by J. F. Walker. 1953. New York: Reinhold Publishing Corp.

"Maleic Anhydride Derivatives," by L. H. Flett and W. H. Gardner. 1952. New York: John Wiley and Sons, Inc.

Colorants for Plastics

BY WILLIAM H. PEACOCK*

To produce the many attractive color effects found in modern plastics, the trade colorists and engineers use many synthetic colorants and a few of natural origin. More than 800 coloring agents are domestically available, each of which might be used on occasion with greater or lesser advantage. On the basis of experience, however, colorists have found that only about 10% of these available colorants are needed in order to achieve all of their effects (1,5,6).[1]

There are three special rules plastics technicians should know:

1) Colorants have different properties in different media; therefore, their properties in one plastic are no certain criteria of their characteristics and adaptability to another plastic.

2) The concentration of colorant and used greatly affects the color results, and also may affect many other properties.

Differing techniques used in processing plastics and their different end-use applications usually place major importance on different resistance (fastness) requirements of the colorants.

Good engineering practice requires that each of these factors

* American Cyanamid Co., Research Div., Bound Brook Laboratories, Bound Brook, N. J.

Recent Developments and References were prepared by the editors.

[1] Numbers in parentheses link to Special References, p. 373.

The author appreciates the helpfulness of the Organic Chemicals Div., Pigments Div., and Research Div. of the American Cyanamid Co. in permitting the use of certain data from their files.

Nothing contained herein shall be construed to constitute a permission or recommendation to practice an invention covered by a patent owned by the American Cyanamid Co. or by others without a license from the owner of the patent.

RECENT DEVELOPMENTS

An extra-conductive oil furnace carbon black (*Vulcan R XC-72*, Godfrey L. Cabot, Inc.) is available for use in antistatic and highly conductive rubber and plastics compounds. The low resistivity of this new black, compared to other conductive carbon blacks available commercially, is attributed to its small particle size, high degree of permanent chain particle structure, low volatile content, and high surface area.

A new high-strength phthalocyanine blue pigment (*Cyan Blue Toner XR 55-3760*, American Cyanamid Co.) is designed primarily for use by the plastics, rubber, and floor-covering industries. It is said to possess good heat and light resistance and to provide ease of dispersion and good strength development even under adverse milling conditions.

Special dispersions for injection molding (*Formacolor LP*, Westchester Plastics, Inc.) and for extrusion (*Unicolor LP*) of linear polyethylene have been developed. The colorants are mixed in a linear polyethylene base to form masterbatches which can then be extended by the molder or extruder using them.

A colorless fluorescent agent (*Tinopal PCRP*, Geigy Chemical Corp.) converts invisible ultraviolet radiation into visible bluish light which acts to mask yellowing. When used as an additive it improves brightness and whiteness of products made from polyethylene, styrene, vinyl acetate, and other plastics. It comes in powder form and is added to the polymer prior to milling or mixing.

A line of concentrated color dispersions (*"PC,"* California Ink Co., Inc.) offers great color strength and is compatible with a wide range of materials, including cellulose nitrate, acetate, butyrate, vinyl acetate, polyesters, polyurethane foam, chlorinated rubber, and certain acrylics, epoxies, and nylon-epoxy mixtures. The vehicle is a polymeric general-utility plasticizer.

Reduced cadmium pigments (*Cadmopone*, Ferro Corp., Color Div.), available in medium-red, orange-red, and orange, are permanent, nonbleeding, nonfading, and resistant to heat, light, acids, and alkalies. They disperse readily in thermoplastics.

Two concentrated colloidal dispersions of carbon black (*Co-Acrylateblak NC-1401* and *Coblac 405*, Columbian Carbon Co.) offer special advantages and economies to manufacturers of high-grade acrylic lacquers and cellulose nitrate lacquers. Lacquers formulated with these dispersions will produce high jetness, mirrorlike gloss, and smooth surface.

Aqueous colorant dispersions (Kentucky Color & Chemical Co.) are available as high-strength colorants for use in three-component polyurethane foam systems.

Nineteen basic color pastes (*4000 series*, Claremont Pigment Dispersion Corp.) for use with polyester resins produce greater color uniformity in reinforced plastics products than do dry colorants. The pastes are added to the resin before the curing agent.

Twelve color pastes (*Stan-Tone PEC*, Sinclair & Valentine, available from Harwick Standard Chemical Co.) do not retard cure nor accelerate set time of polyesters.

A new color concentrate (*RV-300*, Logo, Inc.) has been developed for silk screening and roller coating of all plastics, except cellulose acetates. Inks are made from the concentrate by adding a clear base and thinners to secure the desired gloss and viscosity.

be taken into account before deciding on the proper colorant to be used.

Rule 1—*Colorants have different properties in different media:* The benzidine yellow toners, for example, have better heat resistance in regular polystyrene than in high-impact polystyrenes. The cadmium reds and yellows, ultramarine blues, and other acid-sensitive colorants are widely useful, yet should be avoided in coloring plastics that liberate acids at high temperatures, e.g., polyvinylidines. In contrast, the iron blues are more suitable for plastics using acidic, not alkaline catalysts.

The nigrosine hydrochlorides, which give excellent gloss blacks in phenolics and cellulose esters, must be used with caution in the aminos, whose curing they accelerate, in shellac compositions, which they quickly "deaden," and in some polyvinyl formulations, in which degradation may be induced. Such stable pigments as the carbon blacks and phthalocyanine blues have strong inhibiting (anti-oxidant) effects on the curing of polyesters and other peroxide-catalyzed polymerizations. Although the titanium dioxides are usually the white pigments of choice for most plastics, they may darken under strongly reducing states. The anatase and rutile types vary in usefulness.

The manganese, copper, and zinc derivatives of colorants may induce devulcanization or degradation, particularly in elastomerics, a feature also shown by some natural earth pigments. While the lead chromate yellows stabilize polyvinyls, the zinc chromates have a reverse effect. Certain vat dyes have good light fastness on cellulosic fillers, yet fade within one or two hours in polyvinyls, and only a few give good results in both applications. A number of "oil-soluble" dyes have very good light fastness in polyacrylates and polystyrenes, yet they tend to fade rapidly in cellulose esters. These same dyes are useful colorants for rigid thermoplastics but effloresce and otherwise migrate badly from plasticized formulations.

Lithol reds often yield brighter color effects in compositions stabilized with barium-cadmium soaps than with certain lead and tin stabilizers. Both dyes and pigments vary in their bleeding resistances in aqueous urea and phenolic-aldehyde glues, glacial acetic acid, rubber cements, and lacquer-type and pressure-sensitive adhesives. Many dyes that are useful in thermoplastics are unsuitable in polyethylenes.

Rule 2—*The effect of colorants tends to vary with the concentration used, not only in color results but in other properties:* Colorants appear faster to light in strong color effects than in pastels and tints, or as a minor component of a colorant mixture. Pigment scarlet is somewhat of an exception for, although it darkens more than duller scarlets, it yields faster pinks or red violets than other organic red pigments. Many colorants crock (rub off) less when used at concentrations below rather than above 0.25 percent. Although small percentages of dyes and pigments have a limited anti-oxidant effect, in larger proportions they may delay for days the oxidative drying of oleoresins and retard or inhibit the complete curing of peroxide catalyzed polymers.

Colorant concentration is also important. Increasing the colorant concentration, for example, can quench the fluorescence, affect bronze (2), and produce the widely prevalent dichromatic effects. Illustrative of dichromatism is the action of F. D. & C. Red No. 2 (C. I. 184), (3) which in gelatin plastics yields magenta (0.05%), scarlet (0.125%), or red orange (0.3%) color effects.

Similarly, most bluish-red pigments yield red violet tints or halftones, and the orange toners commonly yield pink tints. The more transparent pigments may appear black in masstone, an effect which can be overcome by adding some white pigments. For example, iron blues reduce from

(Continued on p. 372.)

COLORANT GROUP CHARACTERISTICS

DYES

By the most generally accepted definition dyes are distinguished from pigments by their property of being soluble in some commonly available liquid, which in the plastics field may vary in nature from alcohols, esters, hydrocarbons, and polyethylene glycols to water. As a group, dyes are also characterized by wideness of color range, brightness, high tinctorial power, good transparency, low specific gravity, and high bulk in air. The individual dyes vary greatly in all the properties that determine their suitability and adaptability for coloring plastics. All will bleed when brought into contact with their solvents.

For discussion of their properties of major importance in the coloring of plastics, dyes may be classified into the following groups:

(1.) *Nigrosines and indulines:* These azine group dyes, particularly the bases, hydrochlorides and sulfonates of the nigrosines, are used in greater quantities than all the other dyes together in the plastics field. They are probably surpassed in volume only by the titanium dioxide pigments and the carbon black rubber-tire fillers. They yield bloomy, gloss black effects, have high tinctorial power, good heat, light (full blacks) and aldehyde resistance. The *bases* are dispersible readily in many types of plastics and, although insoluble in water used alone, they are moderately-to-highly soluble in an amazing variety of other liquids, e.g., in alcohol-toluol (25%), water-acetone (13%) and alcohol-acetone (40%) mixtures, furfural (50%), glycol ethers (10%), polyethylene glycols, fatty acids (30%), fatty acid alcohols, phenol (9%), cyesylic acids (9%), ethyl lactate, dichlorethylene, aniline, nitro and chlorobenzenes, pyridine, dioxan (7%), methyl isobutyl ketone (3%), methyl normal amyl ketone (9%), and diacetone (12%). (Their solutions and/or dispersions in fatty acids are sold as "Oil Blacks.")

Certain grades are useful where dielectric effects are important, particularly in phenolic molding compounds and laminating varnishes. They are resistant to many chemicals, stabilize shellacs, but are less adaptable for polyvinyls, greatly delay the oxidative drying of oleoresins, and tend to inhibit peroxide catalyses.

The *hydrochlorides* yield the same bloomy, gloss blue blacks as their bases and have many of the same resistance and solubility features, although being more soluble (18%) in alcohol. These dye-salts are particularly adaptable for coloring cellulose esters and phenolics, including the cast phenolics, but must be

used with caution in plastics affected by hydrochloric acid because of their tendency to hydrolize at high temperatures.

The *sulphonates* are water soluble (25%), give blue to jet black color effects and have moderate tinctorial power, heat, and light resistance. They are useful for coloring the water-soluble plastics.

(2.) *Oil-soluble and "acetate" dyes:* These dyes are substantially free of salt-forming groups and therefore are insoluble in water, but soluble in a wide range of nonaqueous liquids. They yield a wide range of color effects, are moderately bright, highly transparent, low in specific gravity, have high bulk in air, and good heat resistance. Many tend to soften and melt in the 95 to 140°C. range, making them easily dispersible in hot processing, although some may sublime; yet they yield specky effects, unless carefully diluted, in dry-blend-coloring. They have very good fastness to light in those plastics, such as polystyrenes, which are free of combined oxygen, yet are rather fugitive to light in many other plastics. They tend to effloresce and migrate from plasticized stocks, have moderate-to-very good resistances to aldehydes, and are strong anti-oxidants.

The *"acetate"* types are usually mixed with wetting agents and therefore yield dispersions in water, from which the cellulose esters and some other synthetic fibers selectively absorb them. This dye group, when dissolved in carefully balanced solvent mixtures, is used as 'dip-dye' stains for many thermoplastics.

(3.) *Acid, chrome, direct, developed dyes:* These dyes are usually sodium salts of colorant acids. Of the hundreds available, only a limited number regularly are adapted as colorants for plastics. They yield a wide range of color effects, bright and transparent. In specific gravity they range from 1.05 to 1.5, but because many are usually admixed with inorganic salts, they vary greatly in their bulk in air, dispersion, and solubility properties. These dyes are adaptable to coloring thermosetting, casein, gelatin, and cellulose ester plastics, regenerated cellulose films, and various types of fillers, and are particularly adaptable for compositions having water-soluble phenolic or urea-aldehyde resins, polyvinyl alcohol, methyl cellulose, carboxy cellulose, dextrine, latex, mucilage, starch, shellac, and other water- or spirit-soluble binders. The acid and chrome dyes have affinity for proteins, particularly under acid conditions. The direct and developed dyes are substantive to cellulose fillers, particularly under acid conditions. The direct and denumber of these dyes can be dissolved in glycol ethers to yield stains substantially free of inorganic salts.

(4.) *Basic dyes—basic dye bases:* The colorant nucleus of these dyes is positive, so that they appear as dye chlorides or oxalates (water-soluble) or as bases (organo-soluble), although not all the bases are available. These dyes contain probably the brightest of all dyes, give a wide range of color effects of fine beauty, are transparent, intensely powerful tinctorially, and, in general, have good resistance to heat and aldehydes, but are fugitive to light. They have affinities for amphoteric materials and tannate mordants and are absorbed by some clays. They are highly soluble in alcohols. The bases are also sparingly soluble in toluene. The dye salts tend to hydrolyze and split off acids so that their use should be avoided where this action is important. The *rhodamines, safranines,* and *methyl violets* are available in grades that disperse well in phenolics.

(5.) *Sulfur dyes:* These dyes are soluble in water containing alkaline reducing agents, particularly sodium sulfides or hydrosulfides. They are rarely added directly to resins, but find their greatest usage in coloring cellulosic fillers, particularly for rubber goods. There are no bright red sulfur dyes. In general these dyes show good resistance to light, migration, and reagents, and are moderately heat resistant. As organic sulfides, some stain metal molds and inserts.

(6.) *Vat dyes:* These dyes also are soluble in alkaline reducing solutions, have moderate brightness, low tinctorial power, and very good resistance to heat and reagents, but they vary greatly in light and bleeding characteristics. Helidon pink Pr 109 (1) is used for bright, clean fluorescent pinks in thermoplastics, although having relatively poor fastness to light. Properly applied to cellulosic and amphoteric fillers, many vat dyes have good resistance to fading. When in solid solution in a plastic they tend to be fugitive.

(7.) *Brighteners:* The so-called "brighteners" are a special group of "white" dyes that usually have little or no self-color, but which transmute ultra-violet radiations into intensely bright visible effects. They are useful in plastics chiefly as "bluing agents" and ultra-violet absorbers. Many are water-soluble but a few are soluble in hydrocarbons and certain thermoplastics. In general, their heat resistance is good, but practically all are fugitive to light.

(8.) *Ultra-violet absorbers:* These are a relatively new group of organic compounds or yellowish-to-nearly-colorless dyes, generally derivatives of hydroxybenzophenones, which have the property of strongly absorbing radiations having wave lengths between 320 and 390 mu. (the near-ultra-violet range). They are fairly resistant to ultra-violet radiation themselves, and seem to function by dissipating the absorbed energy, probably as heat. (This is in marked contrast to the action of many other absorbers of ultra-violets.) In any case, when used in plastics they tend to improve the resistance of the various ingredients to photolytic attack in that range, particularly in transparent or translucent materials. Consequently, they tend greatly to delay the photolytic yellowing and other light-induced degradative effects in the plastics and to increase the fastness to light of many colorants. As these compounds function chiefly in the ultra-violet "black-light" range, they are, of course, of little aid to colorants fugitive to visible range (daylight) radiations. Most of them are insoluble in water, are soluble in organic (plasticizer) liquids, usually melt below 200° F., are reasonably resistant to heat, and disperse readily in hot-processed plastics (2b).

(9.) *Anti-oxidants—anti-ozonants:* These are usually organic complexes that to some degree tend to protect plastics from aging effects induced by ozone and oxygen. They often have some self-color. Designed to be reasonably stable to processing conditions and to other reagents, their incorporation in rubbers and other elastomers helps prolong the plastics' life.

ORGANIC PIGMENTS

As a colorant group, the organic pigments are characterized by very limited solubility in most commonly available liquids, a wide color range, good brightness, moderate-to-good tinctorial power, generally low specific gravity, high bulking ratios, high oil and plasticizer absorption, and their much greater resistance to bleeding versus dyes (6). Individual organic pigments, of course, vary widely in their resistance properties and adaptability for coloring plastics. They are most generally useful for plastics for interior applications.

Pigments can be divided as follows:

(1.) *Lithol Reds* are a group of vivid, tinctorially strong pigments widely useful where moderate resist-

ances suffice, as in various thermoplastics and rubber. They exemplify the influence of the metal precipitant on colorant properties, as the color, heat, and bleeding fastness tends to increase from the sodium (yellowish-red), barium (scarlet), calcium (crimson) to the resinated calcium maroons.

(2.) *Certain Naphthosol (B.O.N.) reds, Lithol rubine, and pigment scarlet,* and, to some extent, the *barium toners of Lake Red C* comprise a group having the heat, light, and migration fastness to adapt them for coloring heavily plasticized compositions.

(3.) *Toluidine, para* and *chlorinated para red toners, Brilliant Red Lake R, bronze orange,* and the *nitraniline* and *dinitraniline orange toners* comprise a pigment group yielding very bright, translucent scarlet and orange colors, having good tinctorial strength and moderate-to-good heat- and light-resistance, but which have very poor migration resistance in plasticized stocks. They are useful colorants chiefly for amino and some cellulosic esters.

(4.) The *benzidine oranges, benzidine yellows,* and *Hansa Yellows* yield very clean, bright colors, and have moderate-to-good resistance properties. However, they must be used with judgment. For example, the Hansa Yellows give excellent results in urea-aldehydes, but effloresce from many thermoplastics. The tinctorial strength of the benzidine yellows is worthy of special notice, as they are tinctorially twice as strong as the Hansa Yellows and ten times as strong as the chrome yellows.

(5.) The *phthalocyanine greens* and *blues* are characterized by having resistance properties which meet the requirements for coloring many plastics. However, their anti-oxidant effect inhibits the curing of peroxide catalyzed polymerizations, and they sometimes disperse poorly, particularly in dry-blend-coloring processes. Their dark masstones are approached closely and with practically equal fastness, much less anti-oxidant action, and lower cost by the chrome greens and iron blues. Certain types of phthalocyanine blues lose tinctorial strength on aging in some media, probably due to crystal growth and flocculation.

(6.) The *phoshotungstic acid (P.T.A.), phosphomolybidic acid (P.M.A.),* and *tannic acid toners* of the *rhodamines, basic greens, victoria blue,* and *methyl and crystal violets* give bright, transparent color effects and have generally good resistance to heat and aldehydes. However, unlike their effects in certain surface coatings and inks, they all have poor resistance to light and reagents in plastics. They are used chiefly where their dispersion properties are superior to dyes, but, in general, dyes are as useful and cost less.

(7.) *Acid dye lakes—Bordeaux B, Scarlet 2R, Orange 11, tartrazine, fast light yellow, chinoline yellow* and *Patent Blue* dyes are used as the nuclei for pigments, usually on aluminum hydrate substrates. These complexes yield bright color effects moderately-to-highly transparent, reasonably resistant to heat and aldehydes, and with moderate-to-good dispersion properties in most plastics. Their resistances to light and migration are poor, however. The dyes themselves usually show better fastness to light than the corresponding lakes, so that these pigments are used chiefly where their better dispersion properties are essential

(8.) *Carbon blacks* have excellent fastness properties and large quantities are used for improving the weather- and abrasion-resistance of polyethylenes and rubbers. However, they must be used with caution in certain plastics as they are anti-oxidants and tend to inhibit the functioning of peroxide catalysts, to conduct electricity, and have such high resin and plasticizer absorbencies that they may affect flow and flexibility. They may also bleed on occasion, since some of them contain about 0.5% of benzol extractives. Colorwise, they tend to yield low gloss, matte blacks in many media, and give brownish grays, unless toned with *alkali blue toners* or other pigments. Spectrally they are characterized by having rather flat absorption curves over a wide range of wavelengths.

(9.) *Van Dyke Browns* are carbonaceous pigments from humus and peats which give dull brown color effects of moderate fastness. They are more commonly classified with the natural earth pigments.

(10.) *Browns:* Organic pigments for brown color effects are usually blends of orange (or red and yellow) pigments with blues and/or carbon blacks. Most of them yield dicromatic effects.

SYNTHETIC INORGANIC PIGMENTS

As a group, these pigments yield bright colors at strong concentrations but their tints and pastel colors are often dull. With a few exceptions they are tinctorially very weak, have high specific gravities, low oil and plasticizer absorption, are somewhat coarse and hard in texture, but usually disperse well, yet may appear specky in thin films, and have very good to excellent heat, light, and migration resistance. Their chemical resistance, while usually good, varies greatly with the pH conditions. They have much less anti-oxidant effect and better weather resistance than the organic pigments. The iron blues and ultramarine blues are transparent, as are the yellow iron oxides in some media, but most of the group are opaque.

(a) The *titanium dioxide white pigments* are characterized by their relatively high tinctorial strength, excellent hiding power, high bulking values, extremely high opacity (high refractive index), excellent resistance to heat, light, and migration, and very limited chemical reactivity. These outstanding features make them the most efficient white colorants for nearly every plastic, and consequently they are used in larger volume than any other pigment in this field, except for the carbon black rubber-tire stock fillers. There are two series of these pigments, the "rutile" and the "anatase," which, though chemically similar, seem to vary in their structural geometry. The rutile types yield slightly yellower whites (by reflection), are approximately 20% stronger tinctorially, a little more opaque, and somewhat more inert chemically than the anatase types. Both types are very useful for producing translucent and opaque effects, the amounts needed varying of course with the thickness of the sheet or piece. For example, the use of 0.05% of a rutile-grade titanium dioxide will impart a fog or haze to the 0.025-in. thick, and an opalescent (not irridescent) effect to the 0.200-in. step of the familiar stepped testing piece, using crystal polystyrene, whereas the addition of 1% of the pigment will produce opacity in the 0.025-in. step.

These pigments scatter light so greatly that the addition of 0.1% usually is sufficient to "bring out the color," that is, to convert blackish and dark masstones into undertone effects. Similarly, by adding 2 to 10% of these pigments to dark phenolic and petroleum resins, shellacs, asphalts, and gilsonites the self-colors of these resins can be tinted from browns to light tans, which can then be given at least soft-toned hues by the further addition of chromatic colorants.

These pigments are often used in the surface sheets of laminates to fill the valleys between the filler flocks, resulting in the production of uniformly-colored rather than mottled-effect surfaces. The un-

treated pigments are strongly hydrophilic, so they can be incorporated in latices and other water-soluble plastics. For dry dispersions, it is advisable to use the special grades produced for those processes. Despite their generally excellent fastness properties, these pigments have the adverse features of being subject to attack by strong reducing agents, may even go slightly grayish in certain aminos, and specific grades, particularly some anatase types, may advance the degradation of polyethylenes and some polyvinyl formulations.

The *zinc sulfides* are white pigments yielding bright whites, have medium tinctorial strength, good hiding power, excellent resistance to light and migration, good heat resistance, and disperse well. They are used chiefly in certain phenolic and urea-aldehyde plastics but should be avoided for polyvinyls.

The *lithopones* are zinc sulfide-barium sulfate complexes that have practically the same properties and uses in plastics as the straight zinc sulfides.

The *zinc oxides* give bright whites, have moderate tinctorial strength, good opacity and hiding power, high specific gravity, good resistance to heat, light, and migration, but are rather reactive chemically, tending to form soaps with organic acids, and may cause hydrolysis of plasticizers at high temperatures.

The *white-lead pigments* give bright whites, have moderate tinctorial strength, good opacity and hiding power, very high specific gravity, and good resistance to heat, migration, and light (darken with sulfur fumes on weathering). These pigments are toxic and somewhat reactive chemically, but they tend to stabilize polyvinyl compositions, although not quite as well as specialty derivatives (i.e., phospites and phthalates).

Antimony oxides yield moderately bright whites, have only fair-to-moderate tinctorial strength, good opacity and hiding power, and good fastness to heat, light, and migration. Chemically they are moderately reactive. They probably find their greatest usefulness in "flameproof" compositions, reducing flammability.

(b) The *cadmium pigments* yield clean yellows, bright scarlets and maroons, dull pastels and tints, but are very weak tinctorially. Their heat, light, and migration resistances are good-to-excellent, and their chemical resistance is good, except to some acids.

(c) *Vermillion* is more useful in artists' paints than in plastics, as its light- and heat-resistance is erratic. *Red lead*, *litharge*, and *orange mineral* are probably used more as stabilizers and primers than as colorants.

(d) *Molybdate oranges* and *chrome oranges* yield moderately bright orange and scarlet blends, have good resistance to heat (although they tend to darken more in intensive mixers than during hot rolling), have excellent nonmigrating properties, darken with light, are resistant to alkalies, but are affected by some acids and reducing agents.

(e) The *chrome yellows* give clean hues initially, but tend to darken and go greenish in color on exposure to light and weathering. It is probable that some small percentage of chromium oxide may form but in any case this darkening in no way detracts from their great usefulness in pigment blends to produce greens. These yellows have a stabilizing action in polyvinyls and are useful in polyethylenes.

Zinc yellow has a bright, clean, greenish yellow hue, but because it tends to leach into water it is used more in primers than in molded plastics and its use in polyvinyls should be avoided.

(f) The *chrome greens* (iron blue-chrome yellow compositions) have dark masstones, clean undertones and tints, very good resistance to heat, light, and migration, little to no anti-oxidant effect, good acid resistance, and are low in price. They have poor alkali resistance. They are useful in peroxide catalyzed plastics. Normally they disperse well, but because of differences in specific gravity, surface area, and particle wetting characteristics, their yellow and blue components may tend to separate in certain applications.

The *chromium oxide greens* are characterized by softness of color tone, weak tinctorial power, opacity, and great durability (being affected only by strong reagents). In combination with cadmium maroons they yield attractive, useful, very fast, but somewhat expensive gray effects.

(g) Although the *ferric ferrocyanides (iron blues)* are usually classified as inorganics, they approach the organic pigments in specific gravity, oil absorption, and transparency, features that make them useful in color filters, in which they tend to absorb the longer wavelengths (red) of light. They have excellent light-, migration-, and acid-resistance, are but moderately heat stable, are sensitive to alkalies, and need the help of sequesterant chelates in certain plastics.

The *ultramarine blues* have outstanding brightness and beauty of hue, good transparency, heat-, light-, migration-, and alkali-resistance. Although sensitive to acids they are widely used for coloring polyvinyls, polystyrenes, urea- and melamine-aldehyde, and polyester plastics. They are less suitable for use in polyvinylidines. Some of these blues, particularly when blended with white pigments, are sold as *"cobalt blues."* These should be distinguished carefully from the *blue-colored derivatives* of cobalt commonly used in coloring ceramics, but some can be adapted for coloring plastics. These latter derivatives give reasonably durable color effects, but are sometimes rather difficult to disperse and have low tinctorial strength.

(h) *Mineral violet* is a manganese complex, has a moderately clean color, low tinctorial strength, high specific gravity, slightly hard texture, and good light-, good migration-, and moderate heat-resistance, is sensitive to alkalies, and degrades elastomeric plastics.

The *ultramarine violets* yield soft-toned, grayish, red violet color effects of very low tinctorial power, which approach the ultramarine blues in properties although not as transparent nor as light resistant.

(i) The *synthetic iron oxides* and *iron silicate blacks* (mineral blacks) give soft-toned colors of low tinctorial power, have high specific gravities, low oil and plasticizer absorptions, somewhat coarse texture, moderate dispersion, and good resistance to heat, light, migration, and chemicals.

(j) *Aluminum* flake products are useful for special "metallic" color effects, particularly in combinations with transparent pigments (iron blues—'blued effects'). Used alone they give opaque, silvery grays with a slight metallic glint, having good tinctorial and hiding power, excellent resistance to heat, light, and migration, and limited resistance to reagents. There are other *metallic powders* available (lead, zinc, zinc dust) but they are rarely used for coloring plastics. Where practical, the premixed pastes (with plasticizers) should be used to avoid dust explosion hazards.

(k) *Luminous pigments:* The luminous pigments are largely specialty metallic sulfide complexes which are characterized chiefly by their property of transmuting ultra-violet radiations into visible light energy. Their color appearance in daylight is generally rather different in hue, very much duller, and much weaker in tinctorial power than their beautiful appearance under ultra-violet ("black") light. The intensity of their brightness in an ultra-violet field may arise from the fact that the light is generated on and emitted by the pigment particles, as in the case of the "brightener"

COLORANT GROUP CHARACTERISTICS (Continued)

dyes. There are two series of these pigments, one which fluoresces, and one which both fluoresces and phosphoresces (after-glows). The luminous pigments usually are high in specific gravity (3.45 to 5.6), have weights per solid gallon of 25.8 to 46.7 lb. (1 lb. bulks 0.0387 to 0.0214 gal.), have good resistance to migration, moderate heat resistance, vary in light fastness, and are moderately resistant to chemical attack, except perhaps to acids. The intensity of their fluorescence can be adversely affected if their somewhat brittle crystal structure is ruptured, so they must receive little grinding, and are therefore preferably used in sheet stocks rather than in thin films.

NATURAL INORGANIC PIGMENTS

The group of natural inorganic (earth) pigments have a limited chromatic color range, being largely limited to soft-toned yellows and browns, have low-tinctorial power, opacity to low translucency, high specific gravity, low oil and plasticizer absorption, hardness and coarseness of texture, and good-to-excellent durability.

(a) The *ochres, siennas, umbers, synthetic* and *natural iron oxides* are used for brown effects in phenolic-aldehyde molding compositions and some other thermosets and thermoplastics. Often they contain impurities that induce degradative effects; the coarser types have been known to plug gates and small diameter sprues and give specky color effects in thin films. At high temperatures, the hydrates tend to lose water and go redder in hue.

(b) *Mica flakes* impart to water-white crystal stocks peculiar grayish effects approaching but more translucent than aluminum flake 'metallics'; the chief use is as fillers to improve electronic properties.

(c) *Aluminum hydrates, barytes, bentonite, calcium carbonates, china and other clays, diatomaceous earth, emery grits, infusorial earth, magnesium silicates, silicas, stearates (soaps), talcs* and similar extender pigments have very weak tinctorial strengths and vary widely in transparency and resistance to heat and chemical action, but their presence as fillers often affects the final color appearance, the color uniformity, hue, brightness, translucency, specific gravity, flow, curing rate, chemical stability, durability, and sound records reproduction properties ('surface'), abrasiveness and abrasion resistance. Some tend to absorb or form complexes with certain water-soluble dyes. The metallic stearates are used primarily as lubricants, stabilizers and gelling agents (plastigels). The dye stearates are "oil-soluble" dyes.

(d) *Specialties:* Certain pigment manufacturers have developed specialties and standard pigments designed to be particularly adaptable to plastics.

(Continued from p. 368.)

blacks, through royal blues, to baby blue tints. Some pigments, such as the cadmium reds, give clean, bright reds, but dull pinks.

Rule 3—*Different processing methods and various applications of plastics usually stress different colorant properties:* Probably no available colorant will meet every coloring requirement. Consequently those who write the specifications should defer to practical considerations and knowledge. For example, it is impractical, and usually as uneconomical, to require a colorant resistance of 500° F. for use in a plastic never processed above 350° F. as it would be to require baby panties to be fast to weathering. Again, the chemical resistance varies in severity and nature for colorants added before rather than after a polymerization or condensation step; for reworked stock rather than for virgin stocks; for containers for pharmaceuticals rather than in cake-boxes; for pipe lines rather than pipe-stems; and for filter-press gaskets rather than for fruit jar rings.

Alkali resistance is highly important for colorants for floor tiles and washing machine impellers, whereas acid resistance may be needed for battery cases. Colorants for dentures and baby toys must not bleed into saliva, while fastness to perspiration is more important for tool handles. Different types of migration fastness are needed for upholstery pipings, to avoid wet transference to paper interleavings, in washing versus dry-cleaning operations, in greaseproof wrappers, and for noncrocking sheet stocks. Dyes for shoe-heel films and fountain pen barrels must meet gloss and solubility specifications of lesser importance for certain electrical goods, while the latter uses may require limiting chlorine-content and dielectric specifications.

The particle size and dispersion properties of pigments are more important for thin-gage inflatables (lumps cause pinholes) and in die extrusions than in thick sheets and knife-coatings. Transparency is essential for jewels and automobile tail-lights, whereas standardized translucency is needed for many lighting fixtures, and certain stocks may have shadowproof opacity requirements. Colorant fastness to light specifications rightly are higher for outdoor than for interior end uses; for light-resistant plastics than for those which quickly go yellow or self-darken photolytically; for window draperies than for dress shields and trusses; and may be of only minor interest in parts hidden from view inside a machine. Unlike the two halves of an electrical plug, a thick-walled box and its thinner-walled cover may be subjected to different molding conditions, yet in both cases color difference tolerances may have to be much smaller than for many single pieces.

Recoloring scrap stocks

The recoloring of scrap and reworked stocks is a specialized art, particularly with mixed multicolored materials. It is important to note that the stability and fastness properties of the colorants originally present or developed by aging (yellowing) and processing (toasting) are reflected in the properties of the final color match. Scraps containing fugitive colorants will tend to give fugitive final color effects. The relative transparency or opacity is also a factor. Moreover, dark-colored stocks usually must be lightened in "color value" and "saturation" before they can be recolored to brighter hued effects (usually accomplished by adding white or light gray pigments). Often however, the amounts of such pigments that may be added might be limited by their tendency to

absorb plasticizers (oil-absorption) and thereby reduce greatly the flow characteristics of the stock. Accordingly, when this occurs, the addition of some virgin stock may be necessary in order to permit more pigment to be used.

Special References

(1) American Association of Textile Chemists and Colorists. "Year Book," Howes Publishing Co., New York, yearly.

(2) Proceedings of The Perkin Centennial, September 1956, Ogden Printing Co., New York (March, 1957).

a—Godfrey, George J., "The Application of Colorants to Polystyrene and Modified Polystyrene," Koppers Co., Inc., Kobuta, Pa.

b—Hardy, W. B. and Coleman, R. A., "Ultra-violet Absorbers in Plastics," American Cyanamid Co., Bound Brook, N. J.

c—Hines, Frank J., "The Application of Colorants to Polyethylenes," Catalin Corp. of America, Fords, N. J.

d—Ingle, G. W., "The Preparation and Use of Special Polystyrene Color Standards for Fresh and Processed Foods," Monsanto Chemical Co.

e—Kelton, S. C., Jr., "Colorants for Acrylic Plastics." Rohm & Haas Co., Bristol, Pa.

f—Whitacre, H. M., "The Application of Colorants to Rubber and Other Elastomeric Plastics," Akron Chemical Co., Akron, O.

(3) Peacock, William H., "The Practical Art of Color Matching," American Cyanamid Co., (1953).

(4) Peacock, William H., "Types of Colorants for Plastics," MODERN PLASTICS *31*, 74 (Nov. 1954).

(5) Rowe, F. M., "Colour Index," Society of Dyers and Colourists, Bradford, Yorkshire, England. 1st Edition (1924); 2nd Edition, Vol. 1 (1956).

(6) Scientific Section, National Paint, Varnish and Lacquer Assn., "Raw Materials Index," Washington, D. C. (September 1955).

References

Consult the Subject Index for additional information on dyes and pigments. For sources of colorants for plastics, see Directory Index, p. 1018.

"Measurement and specification of color and small color differences," by W. J. Goodwin, MODERN PLASTICS *32*, 143 (June 1955).

"Colors for polyesters," by Cowee and Moffett, MODERN PLASTICS *32*, 113 (Oct. 1954).

"Coloring the fluorocarbons," by J. R. Jones, MODERN PLASTICS *32*, 111 (Oct. 1954).

"Color in the resin-rubber plastics," by W. J. Coughlin, MODERN PLASTICS *32*, 113 (Sept. 1954).

"Cellulosics: color unlimited," by R. I. Hawley, Jr., MODERN PLASTICS *32*, 115 (Sept. 1954).

"Acrylic color techniques," by Stanton C. Kelton, Jr., MODERN PLASTICS *31*, 99 (Aug. 1954).

"Color in styrene and its alloys," by T. H. Insinger, J. T. Guyol, and J. J. McGovern, MODERN PLASTICS *31*, 101 (Aug. 1954).

"Coloring polyethylene," by W. J. Goodwin, MODERN PLASTICS *31*, 104 (Aug. 1954).

"Colorants for vinyls," by D. H. Parker, MODERN PLASTICS *31*, 106 (Aug. 1954).

"Some problems in the dispersion of pigments for plastics," by P. Lowe, Brit. Plastics (Aug. '54).

LUMINOUS PIGMENTS FOR PLASTICS*

Luminescence is the phenomenon which results from the absorption of light energy of one band of wave lengths, and the emission of this energy (with some loss) at longer wave lengths. If luminescence persists for a noticeable duration after the exciting radiation is removed, it is called phosphorescence.

Phosphorescent molding compounds: These compounds emit a glow in darkness that lasts for as long as 10 hr. or more, depending upon the intensity of activation and type of base used. Plastics available in phosphorescent form include styrene, butyrate, polyethylene, acetate, vinyl, acrylic, and polyesters. Originally, these were used primarily in the manufacture of toys and novelties, but are now finding application in such fields as electronics.

Phosphorescent plastics, when exposed to light, have a high initial brightness in the dark, depending upon the activation given. The distance at which objects will be visible depends on the surface area and the amount of pigmentation used. The daylight color in most cases is ivory and the afterglow is blue or green. The green, while having a high initial brightness, has only half the life of the blue afterglow.

Fluorescent pigments are characterized by the emission of radiation from a substance while it is excited by incident radiation. They have no perceptible afterglow and require a light source which produces little or no light. This source is called black light and radiates ultra-violet light energy within the spectral range of 3200 to 4200 angstrom units with the peak of energy radiation at 3600 to 3650 angstroms.

There are two distinct types of fluorescent pigments or dyes: organic dye intermediates and synthetic dyes which are not adaptable to plastics and inorganic pigments.

Inorganic pigments (e.g., Derbylite[1]) are specially manufactured sulfides or combinations. They differ chemically from organic or radium-activated luminous pigments and derive their fluorescent characteristics from a high-temperature heat-treating process. In general, the inorganic fluorescent pigments of the sulfide types have greater light fastness and are adaptable to all types of thermoplastics and thermosets. These pigments are stable and will withstand outdoor exposure over an extended period of time, provided they are used in connection with the proper vehicle. They can be made to withstand heat up to as high as 1800°F. and have been used successfully in polyester bases for silk screening inks.

* Prepared by W. A. McCallum, Luminous Resins, Inc., 166 W. Washington St., Chicago, Ill.

* Trademark, Luminous Resins, Inc.

Destaticizers

BY E. E. ZIEGLER*

RECENT DEVELOPMENTS

A slip agent (*FO-255 Slip-Eze*, Fine Organics, Inc.) for use in polyethylene has antistatic properties, does not impart color to the product, is low in soap and fatty acid contents, and low in toxicity. The material is supplied as a dry powder to facilitate mixing with the extrusion compound.

An all-purpose plastics cleaner (*Spac*, Edison Chemical Co.) claimed to have prolonged antistatic effectiveness is applicable to all plastics materials, fibers, and coatings. The company states that it will not cause crazing or discoloration, or in any way affect the surface finish.

A compounding material (*Antistat A*, Baird Chemical Corp.) for plasticized vinyls renders the product virtually free of static charges. The destaticizer is a compatible, conductive liquid, light amber in color, which is easily incorporated into the resin without noticeable effects on the properties of the vinyl.

An antistatic coating (*Gencote 108*, General Plastics Corp.) for industrial equipment is based on polytetrafluoroethylene (*Teflon*) modified to be electrically conductive. It achieves an antistick, dry-lubricated, chemically inert surface.

Static dust collection in processing, display, and use of molded plastic parts is of widespread concern. Nearly all thermoplastic and thermosetting materials are affected to some degree, the former more severely than the latter.

As a result of investigations into the origin, polarity, and magnitude of static charges on plastics, much has been learned which, although it has not yet resulted in widespread use of destaticized plastic materials, has led to the development and use of a number of destaticizers for application to the surfaces of finished molded articles.

Static on polystyrene

Polystyrene is more apt to accumulate dust deposits than any other thermoplastic. The excellent electrical characteristics of polystyrene have been recognized for years and used advantageously in a wide variety of applications. Unfortunately, the high resistivity of polystyrene does not permit static electric charges that develop on its surface to be neutralized or to be conducted to ground. For this reason, it holds static charges for long periods of time; the result is a tendency to attract and accumulate dust particles. This problem is most severe when colorful polystyrene moldings are exposed in a dry, dust-laden atmosphere. The dust accumulations that result are anything but attractive. An attempt to dust off or remove the dust particles by wiping usually results in aggravating the problem.

Creation of potentials

It has been shown that both positive and negative charges exist at random on any untouched surface of molded polystyrene. The highest charges, ranging in potential up to 10,000 v. or more, are of positive polarity and are created during the separation of the chilled molding from the metal mold. The charges of lower potential may be either positive or negative, and may be the result of molding or hot-processing, fabricating, wrapping, polishing, or simply normal handling and storing.

Airborne dust is attracted to and held by the highest electrical charges in the form of branched patterns which, because of their heavy deposit and their resemblance to lightning discharges, are often highly visible and hence very objectionable. Once this type of dust pattern is removed or even disturbed, it will never reappear, except under highly artificial conditions. Dust deposits on static charges of lower order more often take the form of small spots, streaks, or broader smears, sometimes singly, sometimes in combination. Even though removed, they can easily be recreated by a variety of treatments.

There appears to be no relation between dust pick-up by polystyrene and the size, shape, or flow pattern of any molding. Mold lubricants, dyes, and even metallic pigments have no beneficial effect. On the other hand, some mold lubricants appear to aggravate formation of the objectionable branched patterns on polystyrene, and it is known that injection and compression molding processes are worse in this regard than extrusion.

High humidity has no beneficial effect on polystyrene. However, it has an effect on the dust itself and results in decreased dust collection during the more humid summer months.

Preventives

Limited amounts of radioactive elements are ineffective in reducing static effects in polystyrene. Larger amounts are both expensive and hazardous from the health standpoint. Regardless of the amount, at least some forms would be short-lived. It appears that radioactive ingredients do not provide a practical answer to the dust collection problem.

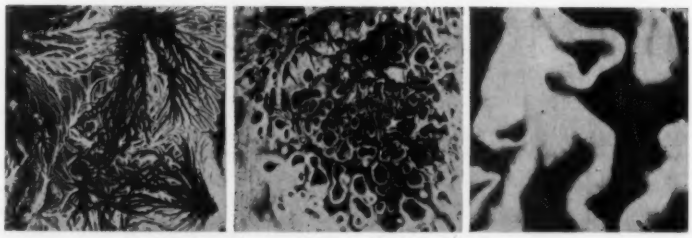
X-ray treatments are effective for a very limited time. Ultra-

* Plastics Technical Service, The Dow Chemical Co., Midland, Mich.
Recent Developments and References were prepared by the editors.

violet radiation is effective only after surface degradation becomes visible. Sulfonation of molded parts is effective, but is hazardous and at the same time rather short-lived.

Of all the plastics tested, polystyrene appears to be the worst from the standpoint of static dust pick-up. Polymethyl methacrylate and polyethylene are next in line, followed by the remaining thermoplastics and thermosets. This correlates with calculations and measurements of surface resistivity, the property that controls the rate at which a static charge can leak off.

If the basic nature of polystyrene could be changed to the extent of making it a conductor instead of an excellent electrical insulator, or if a permanent conductive layer could be established around the material, the problem of static dust attraction would be eliminated. Incorporation of hygroscopic materials in or on the surface of polystyrene might provide a possible solution to the problem, but only if other characteristics such as moldability, heat distortion, and mechanical strength do not suffer because of such incorporation.



Static dust patterns on polystyrene (based on Woodland-Ziegler technique): left—branched pattern; center—spots; and right—smears. (Photo, Dow)

At the present time, the most practical answer appears to be the application of as effective, as permanent, and as inexpensive a destaticizer as can be found (Table I, below).

References

Consult the Subject Index for additional information on destaticizers. For sources of antistatic agents, see Directory Index, p. 1018.

"Electrostatic charges in plastics," by S. M. Skinner, J. Gaynor, and G. W. Sohl, MODERN PLASTICS *33*, 127 (Feb. 1956).

"Static dust collection on plastics," by P. C. Woodland and E. E. Ziegler, MODERN PLASTICS *28*, 95 (May 1953).

"Electrostatic charges on polyvinyl chloride," by B. D. Sully, Brit. Plastics *29*, 103 (Mar. 1956).

"Problems of electrostatic charges in plastics," Brit. Plastics *28*, 335 (Aug. 1955).

TABLE I: Effects of destaticizers

Name	*Manufacturer*	*Use*	*Effectiveness*		*Tendency to craze*
			At 75° F.	*At 130° F.*	
Liquid Joy	Procter and Gamble, Cincinnati, Ohio	2% water solution	Excellent	Excellent	None
Arquad A12	Armour and Co., Chicago, Ill.	2% water solution	Excellent	Excellent	None
Carbowax (8 parts) Tergitol (2 parts)	Carbide and Carbon Chemicals Corp., New York, N.Y.	2% water solution	Good	Fair	None
Anstac M	Chemical Development Corp., Danvers, Mass.	As received	Excellent	Excellent	None
SC9834-1	Standard Toch Chemical Inc., Chicago, Ill.	As received	Excellent	Poor	None
Technistat S	Techniservice, New York, N.Y.	As received	Excellent	Excellent	None
Technistat A	Techniservice, New York, N.Y.	As received	Excellent	Excellent	None
Polishine	Paint Products Labs., Chicago, Ill.	As received	Excellent	Good	Mild
Plasti-Kleen	Spix Products Co., Pittsburgh, Pa.	2% water solution	Excellent	Excellent	Mild
Armac T	Armour and Co., Chicago, Ill.	2% water solution	Excellent	Excellent	Severe
Glim (technical grade)	B. T. Babbitt Co., New York, N.Y.	2% water solution	Good	Fair	Severe
Parko plastic polish	Park Chemical Co., Detroit, Mich.	As received	Excellent	Poor	Severe
Stabilite	Merix Chemical Co., Chicago, Ill.	As received	Excellent	Poor	Severe
Wipe	Merix Chemical Co., Chicago, Ill.	As received	Excellent	Excellent	None

Mold Release Agents

SILICONE MOLD RELEASE AGENTS

BY T. A. KAUPPI*

Silicone release agents separate most plastics cleanly from fabricating equipment, impart a fine finish to the completed part, and help reduce scrap. Because they are exceptionally heat-stable and will not decompose readily, silicone release agents cause little, if any, staining or discoloration of the finished product. They leave no carbonaceous residue, create no dust problem, and markedly reduce clean-up time and mold maintenance.

As a result, silicone release agents are widely and successfully used in a variety of fabrication techniques, including compression, transfer, and injection molding, and in extruding, sheeting, embossing, rolling, and forming plastics.

Types of materials: Many factors are involved in the selection of a release agent. The plastic used, the molding method, the nature of the finished product, and many other similar considerations play a part in determining the suitability of release agents.

To meet different combinations of these factors, silicone release agents have been developed in several forms: solvent-free fluids, emulsions, grease-like compounds, solvent dispersions, and heat-cured resin coatings. Individual situations are often very complex, and actual testing under production conditions is the best method of determining what silicone to use and how best to use it.

Mold preparation: Mold surfaces should be clean and free of organic coatings or films before the silicone release agent is applied.

New or freshly cleaned mold surfaces may need to be conditioned or "broken in" before the release agent is used. This may be done by applying a solvent dispersion of a silicone release agent such as Dow Corning 7 to the surface, then heating to molding temperature or higher for a period of time. Metal molds, for example, are often heated for 1 hr. at 500° F. After the mold is cooled and excess compound wiped off, release coating is applied.

Application of release agent: Methods of applying the silicone release agent vary, depending on the type of fabricating and the results desired. Similarly, the concentration used also varies.

In some applications, various forms of silicone release agents can be used interchangeably; in others, only one form will work effectively. In some applications, the release agent is applied every cycle; in others, the release agent is used in a manner that gives optimum, multiple release from a single application. Literature is available from manufacturers that lists typical field uses.

The silicone release film may, in some cases, interfere with the painting of plastics. If paint or some other finish coating is to be applied to the molded part, the use of a silicone release agent should first be thoroughly tested. Some silicone films may be removed by wiping with solvent, washing with detergent, or immersing the part in alcoholic-sodium hydroxide solution.

*Manager, Product Engineering, Dow Corning Corp., Midland, Mich.

References were prepared by the editors.

NON-SILICONE MOLD RELEASE AGENTS

BY ERIC O. SONNEMAN†

Mold lubricants, used to solve problems of mold release, fall roughly into three categories: 1) powder or powder-like materials; 2) oils and waxes; and 3) water-soluble waxes, the newest form.

Powders: Aside from graphite, stearates have been the most effective and widely used, including aluminum, barium, butyl, calcium, lead, magnesium, and zinc stearate. The latter has been used in preference to all other stearates. Rejects caused by dust particles have contributed to the diminishing use of these lubricants.

Oils and waxes: Materials of this type used to lubricate molds have as their basis mineral oil, tallow, petroleum waxes (microcrystalline), and, particularly, carnauba wax. Carnauba wax is preferred because of its high melting point and pleasant odor. The problem, however, has been how to remove the wax- or oil-containing film from molded parts to ready them for finishing.

Water-soluble waxes: Mold lubricants containing water-soluble waxes have found a ready market because of their extremely low cost, cleanliness, and proper lubrication.

Used widely and for many years in the rubber, metal, ceramic, and textile industries, many of these water-soluble release agents have polymers of lower glycols as their base. Such materials will burn up and leave no carbonaceous residue. Many of these agents also now contain inhibitors to prevent any possibility of rust-formation on molds, and wetting agents to allow their use in "hard" water localities.

Usually supplied in high concentrations, these lubricants may be diluted by the addition of water at a ratio that may be as low as 6 parts water to 1 part concentrate[1] for polyethylene to as high as 8 or even 10 parts water for acetate, methacrylate, styrene, butyrate, etc. The resulting lubricant has been found to give perfect results if sprayed on after every five shots.

References

Consult the Subject Index for additional information concerning mold lubricants. For sources of lubricants, see Directory Index, p. 1018.

"Integral lubrication of polystyrene," by R. B. Bishop, MODERN PLASTICS 33, 141 (Oct. 1955).

"Plastics processing," Lubrication 39, 129 (Nov. 1953).

†General Manager, Merix Chemical Co., 1021 E. 55 St., Chicago 15, Ill.

[1] This and subsequent data are based specifically on *Merix Mold-Ease Concentrate PCR*, a water-soluble non-silicone mold lubricant.

Stabilizers

BY GERRY P. MACK*

Basic function of the stabilizers used by the plastics industry is to prevent degradation of plastics materials when they are exposed to heat and light either during processing or during the commercial life of the finished plastic product. The largest market for stabilizers, of course, is in the compounding of polyvinyl chloride resins. Since the processing of these resins is carried out at temperatures of 300 to 400° F. and, in some cases, even higher, it is essential that a good heat stabilizer be incorporated in the formulation.

Degradation by heat

The most important degradation reaction that occurs on heating polyvinyl chloride resin is a rapid loss of hydrogen chloride. This loss proceeds through what is known as a "zipper" reaction (see Fig. 1, below). The hydrogen chloride thus released acts as a catalyst in causing the loss of more hydrogen chloride until the decomposition eventually results in conjugated double bond structures (polyenes).

Heat degradation in the vinyl compounds is accompanied by rapid color changes. From its initial colorless state, the vinyl compound progresses through various shades of yellow and brown, until it finally reaches black—an indication of complete degradation. The mechanism of this dehydrochlorination reaction has been studied extensively (1).[1]

The rate of heat degradation can be further catalyzed by impurities present in the resin itself. Such impurities may be catalyst residue, metal contaminants, etc. The catalyst residue, in particular, can increase the rate of dehydrochlorination considerably.

The molecular structure of the resin itself has an important influence on the stability of the polymer. All chlorines in the polyvinyl chloride molecules are not equally stable and it has been suggested (2) that probably the first hydrogen chloride to be lost at the start of decomposition comes from a position that is inherently less stable than others in the molecules. Virgin and degraded polyvinyl chloride resins have been subjected to ozonization, in order to determine the type and location of these weakened or labile structures (3).

Degradation by light

The effect of heat and light on vinyl polymers is closely related. In the case of light degradation, however, there is a more rapid loss of mechanical properties. Oxidation plays an important part in light degradation and the loss of tensile strength and embrittlement of a vinyl film can be rapid unless it is adequately stabilized.

Light stabilizers are not necessarily related to heat stabilizers. However, the trend towards the use of a mixed system of metallic soaps with chelators and epoxy-type compounds has greatly overcome the early deficiencies of stabilizers. It is now no longer necessary, in most cases, to add separate stabilizers strictly for light stability. (The exception is the ultra-violet light absorbers discussed below.)

The organotin stabilizers have exceptional light stability and are particularly effective for outdoor weathering (especially in clear vinyl compounds). The liquid barium-cadmium stabilizers that contain phosphites, when used with an epoxy plasticizer, have good light stability. Vinyls stabilized with such systems have been known to take from 600 to 1000 hr. exposure in a Fadeometer with no discoloration or loss of physicals.

Action of stabilizers

Despite the extensive work done on the mechanism of degradation, very little has been published on stabilization.

In the case of the metallic stabilizers, there seems to be some evidence that they function by preventing color formation rather than by inhibiting the formation of hydrogen chloride (2, 5). The exact explanation for this action is still vague, but recent experimental work indicates that these stabilizers may act as oxidation catalysts and disrupt the chromophoric polyene groups.

It has also been suggested that metal-type stabilizers may function by reacting with the hydrogen chloride liberated during the processing of the resin to form metal halides.

Not only the type of metal used in the stabilizer but also the manner in which the metal is tied up in the stabilizer molecule can have an important effect on the properties which the stabilizer will impart to the vinyl compound. Thus, the anionic portion of the metallic salt can affect the clarity, compatibility, and other properties of the vinyl compound, as well as the stability. For example, when using metallic salts of alkylated phenols as vinyl stabilizers, it has been suggested that, while the metal radical performs a good share of the stabilizing effect, the alkylated phenol portion functions as an anti-oxidant. The phenol portion may also act as an homogenizer for the balance of the stabilizer system, thereby increasing compatibility and also contributing to better stability.

In order for a good heat and

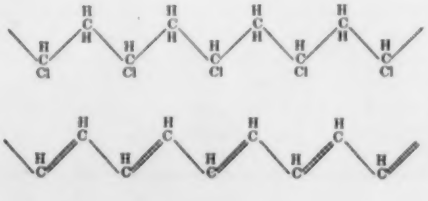


Fig. 1: On heating polyvinyl chloride resin, rapid loss of hydrogen chloride occurs through "zipper" reaction. HCl thus released acts as a catalyst in causing loss of more HCl

* Director of Research, M & T Laboratories, Inc., Metal & Thermit Corp., 1 Union St., Carteret, N. J.

[1] Numbers in parentheses link to Special References on p. 380.

Recent Developments and References were prepared by the editors.

A liquid barium-cadmium organic stabilizer (*Flomax 25,* National Lead Co.) is available for vinyl chloride compounds that require both high clarity and excellent heat- and light-stability. It also assures easy incorporation into vinyl systems due to its liquid free-flowing character.

A sulfur-free, all-purpose organotin light and heat stabilizer (*Thermolite 25,* Metal and Thermit Corp.) is said to be effective with all commercially-available polyvinyl chloride and copolymer resins. Vinyl products stabilized with this material possess good optical clarity, do not cross-stain when placed against vinyls stabilized with lead or cadmium, and have good printability and good heat-sealing characteristics.

A heat stabilizer (*Ferro 1827X,* Ferro Chemical Corp.) for use in rigid and plasticized polyvinyl chloride is a mixed cadmium-barium-fatty acid soap with an organic inhibitor. Properties imparted to PVC compounds by the new stabilizer are said to include clarity throughout processing; no exudation on long-term exposure to strong sunlight; and long-term stabilization at moderate concentration levels. Epoxy additives are said to enhance further the stabilization effect.

A one-package liquid stabilizer (Harwick Standard Chemical Co.) for polyvinyl chloride resins and copolymers is compounded of zinc and barium organic salts with a chelating agent. It can be used alone or with some other liquid stabilizers, or some of the epoxy-type plasticizers.

Three new vinyl stabilizers (*Advastabs CZ-11, BZ-51,* and *BC-30,* Advance Solvents and Chemical) are available. CZ-11 is a fluid paste containing government-approved nontoxic compounds of calcium and zinc, and is principally used in calendering, plastisol molding, and extrusion where nontoxicity is the prime requisite. BZ-51 is a liquid barium-zinc compound combining auxiliary stabilizers, and is said to be especially effective with phosphate plasticizers and heavily-filled and pigmented compositions. BC-30 is a liquid barium-cadmium compound combining auxiliary stabilizers and small amounts of zinc, and is a general-purpose material for use in applications where lubrication is not required.

A purified dialkyl phenol sulfide (*Santowhite Crystals,* Monsanto Chemical Co.), a standard anti-oxidant in the rubber trade, is now used as an anti-oxidant in electrical grade polyethylene. It appears to be a good anti-oxidant for polypropylene, which is much more sensitive to oxidation than polyethylene.

3,3'-Thiodipropionic acid (American Cyanamid Co.) and its derivatives are suggested for use in plasticizers and as anti-oxidants in polymers of ethylene. It has a theoretical molecular weight of 178.20, a melting point of 134°C., and is soluble in hot water, alcohol, and acetone. The material undergoes most of the normal reactions of the dibasic acids. The acid, in certain concentrations, is permitted for use as an anti-oxidant in edible fats and oils.

An anti-oxidant (Catalin Corp. of America, under license from Gulf Oil Corp.), for use in plastics, rubber, and other products, is offered in two grades, technical (*AC-1*) and food (*AC-3*). The product, an alkylated cresol, provides protection from embrittlement and discoloration due to oxidation in vinyl, polystyrene, and polyethylene products.

A new zinc organic complex (*Nalzin,* National Lead Co.) designed as an adjunct for barium-cadmium vinyl stabilizers minimizes or eliminates the staining caused by contact with sulfides. This clear, straw-colored liquid has a specific gravity (25°C.) of 0.915 and is miscible in mixtures of hydrocarbons, solvents with ketones, esters, etc.

light stabilizer to function properly, it should have certain of the following characteristics:

1) It should prevent hydrogen chloride split-off or be an acceptor for hydrogen chloride.

2) It should function as an anti-oxidant.

3) It should react with double bonds, i.e., be a reactive dienophilic molecule.

4) It should act as an ultraviolet light screener.

Possessing such characteristics, the "ideal" vinyl stabilizer would be able to prevent color formation in the vinyl compound during processing, would contribute to the production of clear vinyl film sheeting, etc., and would insure production of nontoxic vinyl products with excellent light stability and weathering characteristics. Obviously, however, no one vinyl stabilizer can perform all of these functions and a wide variety of stabilizers are available to handle each of the functions in varying degrees.

It has also become common to accomplish an end-result by combining various materials, e.g., chelators, anti-oxidants, or epoxy-type compounds added to a metallic salt stabilizer. The stability of a vinyl compound is considerably improved with the addition of 5 parts of epoxy plasticizer. The subsequent addition of one part of a barium-cadmium stabilizer improves stability even further and the final addition of an organic phosphite provides still another increase in stabilizing effectiveness.

Chelators

Metallic salt stabilizers are greatly improved as heat stabilizers by the addition of organic phosphites. This type of stabilizer is commonly known as a chelator.

The current theory in regard to these compounds is that they chelate the metallic halides formed during the decomposition of the vinyl compound, i.e., they tie up the byproduct halide into a complex form and thus increase the clarity and stability of the vinyl composition. Ordinarily, as metallic salts function during heat stabilization, they tend to decrease clarity of the compound, presumably because of the metal-

lic halide salts formed. At this point, the metallic halide salts will also serve to increase the rate of decomposition. By adding the organic phosphites to the compound, both of these actions can be arrested.

At the present time, practically all the chelating-type compounds on the market are based on organic phosphorous compounds. Similar derivatives have been used in the lubricating field as anti-oxidants.

Types of stabilizers

Organotin stabilizers: Stabilizers of this type most closely approach the requirements of an ideal stabilizer as listed above. All classes of organotin stabilizers give outstanding clarity whether the vinyl compound is flexible or rigid. They also have excellent light stability, they are known to function as anti-oxidants, and they have been shown to be the only group of stabilizers that can block the formation of carbonyl groups (C = O) (5). There is also a possibility that organotin stabilizers may function as a dienophile.

A mechanism through which organotin stabilizers may function has been suggested (6). The theory is that a butyl group from a dibutyl tin diacetate stabilizer acts as a chain repairer by adding to the polymer. Presumably, the butyl group could add on to the unsaturated portion formed during the extraction of HCl, thus blocking further action as to cross-linking and oxidation at that particular point in the polymer chain. It is further suggested that the tin stabilizer acts as a scavenger for HCl.

Organotin stabilizers are based on a dibutyl tin-R_2 where R is usually an acid, alcoholate, or mercapto group, or some modification of these.

Dibutyl tin mercapto types are the most powerful group of stabilizers known at present. They are being used in very large quantities, particularly for rigid PVC applications.

A speculation as to how these organotin mercapto stabilizers function has been given (7). There is no doubt that the mercapto group can act as an anti-oxidant and further can react with the double bonds formed during the dehydrochlorination and prevent further color development.

The organotin stabilizers have in some cases been recommended for applications in which the toxicity of the stabilizers is a factor.

Recently, di-*n*-octyl tin compounds have been proposed as nontoxic stabilizers for polyvinyl chloride. It is believed that when the alkyl groups bound to tin are higher than four carbon atoms, the toxicity of the compounds is greatly decreased (8).

Barium-cadmium stabilizers: The barium-cadmium stabilizers comprise an important class of vinyl stabilizers. The synergistic action obtained by the use of an alkaline earth soap such as barium with a heavy metal salt such as cadmium has been intensively explored and has led to a whole series of proprietary types of stabilizers based on this action. In the past, barium-cadmium salts of fatty acids (C_8 to C_{12}), generally lauric or mixed C_{12} type acids, have been used extensively. The drawback to using these types of stabilizers is their lack of compatibility and "plate out" during processing. It is well known that these fatty acids have a tendency to yellow when exposed to high temperatures such as are used in processing vinyl compounds. The octoates which are synthetic C_8 acids have been suggested to overcome this yellowing tendency but they have other drawbacks and are rarely used alone.

These stabilizers can also be improved by the use of chelators and epoxy-type plasticizers, but they are still limited by their incompatibility and tendency to plate out.

Because these drawbacks are found in the *solid-type* barium-cadmium stabilizers, there has been a trend to the use of *liquid* barium-cadmium types.

Recent developments in this field indicate that by utilizing an alkylated phenol as part of the anionic portion of these stabilizers, improved performance can be obtained as to heat and light stability, clarity, improved compatibility, and minimum of plate out. These liquid stabilizers contain a higher ratio of barium than cadmium. Usually a chelator is present.

Cadmium stabilizers: Most cadmium stabilizers are used in conjunction with a barium stabilizer, as discussed above. The cadmium stabilizers usually are based on fatty acids such as stearic or the liquid-type octoates. The use of a chelator with such a stabilizer increases its usefulness. Cadmium octoates in combination with chelators and other organic materials have been recommended for some clear PVC applications. They are, however, limited in such applications to those in which the product will not come in contact with water. Cadmium stabilizers, being metallic soaps, when used in vinyl film that is subject to submersion in water, will "water spot" or become completely opaque.

Lead stabilizers: These stabilizers, among the first types known to the industry, are still used in large quantities today, especially for electrical applications. Varieties are many and run from a lead compound litharge to dibasic lead phosphite. The latter most closely approaches the requirements of stabilizers in that it can function as an acid acceptor, act as an anti-oxidant, and can also react with the polyenes formed.

Lead stearate and dibasic lead stearate are good heat stabilizers and have excellent lubricating properties. They are widely used in opaque vinyl compounds, especially for extrusion.

Zinc stabilizers: This type is always used in combination with another metallic salt in PVC compounds. It is most often combined with barium-cadmium stabilizers, particularly the liquid types. In such stabilizing systems, the zinc salt gives better initial color and helps in preventing sulfur stain.

Major limitation of zinc stabilizers is their sudden exhaustion. When improperly used, instead of stabilizing, they can actually cause a rapid degradation of the vinyl compound.

Zinc, in combination with barium or strontium stabilizers, has been recommended for nonstaining applications.

Zinc stabilizers have also been recommended for use with cal-

cium stabilizers in nontoxic applications. Several such mixed systems are on the market and have been approved by the U. S. Food and Drug Administration.

Calcium stabilizers: These stabilizers have limited application since they do not impart sufficient heat stability to the material to warrant their use alone in the compound. Calcium stearate is used extensively as a lubricant and contributes slightly to the heat stability of the compound.

At present, so-called "approved nontoxic stabilizers" usually are based on calcium soaps plus other nontoxic metals.

Miscellaneous stabilizers: Barium stabilizers in the form of barium ricinoleate, octoate, or similar soaps, have been used for specialized applications. They do not impart sufficient stability to be used by themselves. Their biggest use is in combination with cadmium or other alkaline earth metals.

Strontium stabilizers have been popular in the past for certain applications, particularly in vinyl coating solutions. They are not used to any great extent at present. Some new stabilizers appearing on the market are based on strontium with barium and zinc, and are recommended for applications where sulfur staining is a problem.

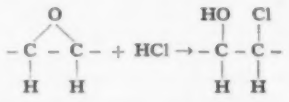
Sodium salts of partial polyphosphoric acid esters have long been used as light stabilizers. They are very poor heat stabilizers and must always be used with an adequate heat stabilizer.

Ultra-violet light absorbers: A group of purely organic compounds that absorb radiation in the ultra-violet portion of the spectrum have become of increasing importance where exceptional light stability is desired. These materials function by absorbing ultra-violet light and dissipating its energy in such a way that it can no longer promote degradation. Materials of this type are based on substituted benzophenones. When used in PVC compounds they contribute to extraordinary light stability. Exposure of compounds so stabilized to 5600 hr. in the Fadeometer has been reported (9).

In general, incorporation of from 0.25 to 1% of these stabilizers is recommended. Their high price, however, has prevented their widespread use in PVC applications.

The ultra-violet light absorbers are recommended for use with polyester resins, methacrylate polymers, styrene polymers, and other similar plastics.

Epoxy stabilizers: The use of an epoxy compound and, in most cases, an epoxy plasticizer, has become a standard part of the formulation of PVC compounds. The ability of the epoxy group to absorb hydrogen chloride is well known and these materials function on this basis, presumably forming the following compound:



The epoxy plasticizers that are the most useful can be divided into three main groups:

1) The epoxy plasticizers based on unsaturated natural oils, particularly soy bean.

2) Monomeric epoxy plasticizers, which are the butyl and higher esters of epoxy stearic acid.

3) Epoxy resins, which are the condensation products of epichlorohydrin and bis-phenol.

The effect of an epoxy plasticizer on the stability of PVC compounds is such that the greatest maximum benefit of these compounds can be obtained by using them in combination with a metallic stabilizer and chelator.

The lower-molecular-weight epoxy resins have limited use in PVC compounds, except in special applications. Their chief drawbacks are high price and relatively limited compatibility with vinyls.

Chlorinated rubber

The requirements for a good stabilizer for chlorinated rubber are, in general, similar to those used for PVC.

The chlorinated film-formers have a tendency to split off HCl even at room temperatures and it has become common to stabilize against this release with epoxy compounds.

Epoxy stabilizers based on the low-molecular-weight epoxy [illegible] ins are most efficient for heat [illegible] bility.

For light stabilizers, the ep[illegible] y compounds are used in comb[illegible] tion with lead stabilizers such as dibasic lead phosphite, as well as barium-cadmium types. As in PVC compounds, no single stabilizer can adequately protect chlorinated rubber and a combination must be used.

Special references

(1) N.B.S. Circular 525, (1951) Symposium on Polymer Degradation Mechanisms.

(2) Druesedow, D. and Gibbs, C.F., N.B.S. Circular 525, (1951) pp. 69-79.

(3) Baum, B. and Wartman, L. H., "Meeting-in-Miniature, North Jersey Section, American Chemical Society, Jan. 28, 1957."

(4) Himmler, G. G. and Nissel, F. R., SPI meeting, Dec. 1956.

(5) Fox, V. W., Hendricks, J. G., and Ratti, H. J., Ind. Eng. Chem. *41*, 1774 (1949).

(6) Kenyon, A. S., N.B.S. Circular 525 (1951) pp. 81-94.

(7) Mack, G. P., "Stabilization of polyvinyl chloride," Modern Plastics *31*, 150 (Nov. 1953).

(8) van der Kerk, G. J. M. and Luitjten, J. G. A., "Tin and Its Uses," July 1955, No. 32 p. 16.

(9) Chemical Week, June 2, 1956, p. 39.

References

Consult the Subject Index for additional information concerning stabilizers. For sources of stabilizers, see Directory Index, p. 1018.

"Stabilization of polyvinyl chloride," by G. P. Mack, Modern Plastics *31*, 150 (Nov. 1953).

"What about stabilizers?" by L. A. Tomka, Modern Plastics *30*, 86 (May 1953).

"Food film fortifiers," Chem. Week *78*, 106 (Feb. 18, 1956).

"Stabilizers for vinyl chloride and its copolymers," by M. Perry and P. F. Bruins, Plastics Tech. *1*, 609 (Nov.); 684 (Dec. 1955).

"Epoxy resins as plasticizers and stabilizers for vinyl chloride polymers," by L. P. Witnauer, H. B. Knight, W. E. Palm, R. E. Koos, W. C. Ault, and D. Swern, Ind. Eng. Chem. *47*, 2304 (Nov. 1955).

Plasticizers

BY GEORGE H. TAFT*

Plasticizers are materials, usually liquid, added to synthetic resins to make the finished product flexible at normal use temperatures or to aid in processing the resins by lowering viscosity of the mixture at elevated temperatures. In most instances, plasticizers are used for both effects.

The first outstanding application of plasticizers in the plastics industry was the use of camphor to facilitate molding and fabricating of nitrocellulose. With the introduction of cellulose acetate and then polyvinyl chloride, the demands on plasticizer manufacturers for products to meet the requirements of these two materials grew stronger. Today, the number of plasticizers being marketed easily tops the 300 figure—with a number of new, improved plasticizer formulations already in the offing.

Mechanism of plasticization

The theories advanced to explain plasticizer action practically always propose formation of some type of loose bond, usually of a polar or hydrogen-bridge type, between the polymer and the plasticizer. This bond formation causes the polymer chains to be pushed apart and to become completely surrounded with a liquid phase. The separation of the polymer molecules is usually observed as swelling. The existence of the liquid cushion around each polymer molecule contributes to softness and flexibility.

Thus, the plasticizing process consists of replacing the polymer-polymer bonds with plasticizer-polymer linkages. This requires plasticizers to have an affinity for the polymer.

Plasticizing action depends upon the types of active centers present in the two materials. For example, esters usually are active toward polyvinyl chloride while water or alcohols are very active plasticizers for the polyvinyl alcohols.

The polymer-polymer bonds present in the original resin cover a broad range of stabilities. Materials which produce plasticizer-polymer bonds of greater stability than the polymer-polymer bonds are active plasticizers and will cause swelling, even at room temperatures.

Primary and secondary plasticizers

Plasticizers are usually classified as either primary or secondary. The primary plasticizer does not bleed or sweat out at normal concentrations and under average use conditions. The secondary type is free from sweating only at low concentrations.

Materials producing bonds of low stability are classed as secondary plasticizers, e.g., alkyl aryl hydrocarbons, etc. Materials forming no bonds are exuded at room temperature, even after processing at high temperatures, and are considered incompatible. In all cases, only a portion of the plasticizer is attached in any way to the polymer, thus leaving considerable free liquid for lubricating effects, migration, and evaporation.

Although plasticization will occur at room temperature with primary plasticizers, the rate is slow. To hasten the process, elevated temperatures and stress, as obtained by milling, calendering, or extruding, are generally used.

Functions of plasticizers

Plasticizers are used to: 1) lower viscosity at the elevated processing temperatures, and 2) impart flexibility to the finished product.

Addition of a plasticizer widens the temperature range over which the polymer normally changes from a solid to a liquid. This is, of course, desirable for processes like extrusion and calendering, but not for injection molding.

The solubility relationship between the plasticizer system and the polymer system is important as regards melting range and viscosity at elevated temperatures. Polyvinyl chloride resins are near ideal because the viscosity-temperature curve at elevated temperatures is relatively flat, making possible practical processing without critical temperature control. With materials such as polystyrene and polyvinyl formal, the viscosity-temperature curve is extremely steep, making processing in a normal manner impossible.

Using the two effects—solubility at elevated temperatures and the effect of the amount of plasticizer on viscosity—the compounder is able to produce a variety of compounds on standardized equipment.

The physical properties of the final compound depend on the amount and kind of plasticizer present. The change of flexibility on lowering temperature is closely related to the viscosity changes of the plasticizer with temperature. As the degree of adsorption on the resin depends on the polar nature of the plasticizers present, the more highly polar, and consequently the ones with the poorest temperature viscosity relationships, are usually adsorbed preferentially. When mixtures of primary and secondary plasticizers are used, this adsorption tends to leave the less polar secondary plasticizers free to act as lubricants and give improved low-temperature properties to the product. By selection of the proper high solvent primary types and use of the proper amount of secondary plasticizer, the compounder can strike a usable average between processing and final properties.

Incorporation of plasticizers

Incorporation of the plasticizer usually begins with a mechanical mixing of the plasticizer with the dry resin, usually by the use of ribbon blenders where the resin is available in powder form. All ingredients of the compound are added to the blender although color pigment may be added later

* Consultant, 9 Monument St., Concord, Mass. Recent Developments and References were prepared by the editors.

Di-2-ethylhexyl isosebacate (*Kesscoflex DOIS*, Kessler Chem. Co., Inc.) when used to plasticize PVC resin contributes good low-temperature properties, excellent resistance to water extraction, and low viscosity in plastisols. It has low volatility and high plasticizing efficiency Di-*n*-butyl isosebacate (*Kesscoflex BIS*) performs similarly to dibutyl sebacate as a plasticizer for PVC, offering high plasticizing efficiency as well as good low-temperature properties.

A primary high-molecular-weight plasticizer (*RC Polymeric BGA*, Rubber Corp. of America) for polyvinyl chloride has good solvating characteristics and superior nonmigrating properties. Compounds prepared with this plasticizer exhibit low volatility, high resistance to extraction by water and oil, and excellent heat and light stability.

A high-molecular-weight polymeric plasticizer (*Emery 3094-S*, Emery Industries, Inc.) features easy processing, light color, and excellent electrical properties, as well as extremely low migration, extraction, and volatility.

A new plasticizer (*Morflex X-1038*, Morton-Withers Chem. Co.) was developed as a replacement for *n*-octyl/decyl phthalates as vinyl plasticizers. An electrical grade plasticizer (*Morflex P-20B(E)*) provides good low-temperature plasticization along with high electrical qualities.

A new modified alkyl phthalate primary plasticizer (*PX-313*, Industrial Chemical Div., Pittsburgh Coke & Chemical Co.) imparts low-temperature flexibility to vinyls equivalent to that obtained with *n*-octyl/decyl phthalates, at an appreciably lower cost. It is recommended for use in high-quality coated fabrics, sheeting, and film; in vinyl jacket wire and other extruded products; and in plastisols.

A phthalate-type plasticizer (*Santicizer 213*, Monsanto Chemical Co.) helps reduce the grip of vinyl chloride surfaces. A 40% content in a formulation gives a Shore hardness of 82 compared with a 73 hardness when a 40% content of DOP is used. It eliminates the need for interleaving in rolls of film, prevents gripping of a vinyl-surfaced product to the walls of cellophane and polyethylene bags, and "slicks" the surface of electric wire coatings.

A low-cost secondary plasticizer (*Chlorowax LV*, Diamond Alkali Co.) for vinyl compounds has low volatility, low migration rate, lack of odor and toxicity, light color, and low viscosity. It is recommended where maximum heat stability and good low-temperature torsional properties are important.

A polymeric plasticizer (*Paraplex G-62*, Rohm & Haas Co.) has been approved by the Food and Drug Administration and the Meat Inspection Branch, United States Dept. of Agriculture, for use in compounds utilized in the packaging and conveying of food products. Approval includes use as a plasticizer in films for packaging bacon, lard, and other meat products in Federally-inspected meat plants, as well as for packaging water-containing food products such as fruits and vegetables.

A new plasticizer (*Plasticizer SC*, Harwick Standard Chemical Co.), a triglycol ester of a vegetable oil fatty acid, imparts low-temperature properties to polyvinyl chloride compositions and nitrile rubber. It is also of considerable value in compounding neoprene. In addition, it is compatible with polyvinyl butyral, polystyrene, coumarone resins, ethyl cellulose, and nitrocellulose. The plasticizer is practically odorless and is soluble in most solvents.

A primary, polymeric plasticizer (*NP-10*, Eastman Chemical Products, Inc.) for polyvinyl chloride compounding is based on neopentyl glycol and combines permanence properties, ease of processing, low-temperature flexibilty, and low color.

A low-cost plasticizer (*Polycon 5B*, Brown-Allen Chemicals, Inc.) for use in vinyl formulations replaces higher-priced *n*-octyl/decyl phthalate where low temperature and low volatility are desirable. In plastisol formulations, it offers good flow-out properties, slow gelation, and fast cure.

N-trichloromethylthio tetrahydrophthalimide, originally developed as an agricultural spray (*SR-406*, Esso Research & Engineering Co.), now shows promise as an additive (*Vancide 89*, R. T. Vanderbilt Co., Inc.) in plasticized vinyl film, making it mold- and fungus-resistant and improving low-temperature flexibility.

---

to avoid contamination of the mixer. With PVC, plasticizers are added by spraying into the mix, preferably hot. The mixing cycle ranges between two and five minutes. The batch may be dumped directly onto a mill, or into a Banbury, or can be barrelled off.

Plasticization is obtained by heating the batch under stress. This may be accomplished by use of rolls operating at differential speeds, a Banbury, or an extruder. Plasticization, complete mixing of the batch, and proper pigment dispersion are obtained in this step.

The plasticized batch is then fed to the final calender or extruder. In some cases, the batch is first pelletized for ease in handling or further compounding.

Plastisols and organosols

The fact that plasticizing action is very slow at low temperature and stress makes possible the

preparation of plasticizer-resin dispersions which can be applied to a supporting medium, usually fabric, or molded before fusion. The dispersion is a viscous liquid which can be applied by the usual coating methods. After application, plasticization is obtained by fusing above 300° F. The heating cycle converts the dispersion to a continuous film or solid.

Such dispersions of plasticizer can be compounded with blowing agents or saturated with a gas, after which the heat cycle causes foaming to produce a sponge product.

Dispersions of plasticizer and resin together with solid compounding ingredients are called plastisols; when more than 10% of a volatile diluent is present, they are called organosols.

As the plastisol viscosity depends largely on the kind and amount of plasticizer present, secondaries such as the adipates may be used solely for their ability to lower viscosity. With organosols, viscosity control is easily achieved by use of the volatile diluent.

Phthalates

Because of the large amounts of plasticizers used with the polyvinyl chloride polymers, most of this discussion will cover plasticizers for PVC, unless otherwise indicated. Plasticizers, of course, also find use in formulations for cellulose acetate, cellulose nitrate, and other plastics as well.

The largest proportion of plasticizers used with PVC is esters, usually of polybasic acids. The phthalates are the major primary plasticizers with the aromatic phosphates leading in the electrical industry. Relatively smaller amounts of the esters of aliphatic dibasic acids are consumed as secondary plasticizers. Due to lack of compatibility, esters of monobasic acids have limited use.

Early studies of the various alkyl phthalate esters showed dibutyl phthalate to be the optimum in solvent power, either increasing or decreasing the alkyl chain length and causing a decrease in solvent power. Because of high volatility, dibutyl phthalate is not used to any extent. The octyl esters are now accepted as the best compromise between solvent power and volatility. The phthalates all show poor low-temperature characteristics. Stability, availability, cost, odor, color, and low toxicity, however, are important in helping the phthalates hold the prime position they now occupy.

The last few years have also seen considerable work being done on developing higher-weight phthalates to replace DOP. The use of mixed alcohols affords some control over temperature-dependent characteristics. Recent products have used alcohols between the hexyl and decyl. The possibility of major improvement in these phthalates is remote, however.

Although the major amount of phthalates are used with PVC, considerable diethyl and dibutyl phthalate go into nitrocellulose lacquers and smokeless powders. Small amounts are incorporated into paint as a plasticizer for alkyd resins.

Phosphates

The phosphates are second in importance in the plasticizer field, primarily because of their low volatility, high plasticizing action, nonflammability, and adaptability to stabilization for electrical use. Their major weaknesses are poor low-temperature properties and odor development. In PVC formulations, the use of small amounts with other plasticizers seems to cause improvement in resistance to bleeding under ultra-violet light. The phosphates generally have a high refractive index, giving additional "brightness" to clear compounds.

An exception to many rules is trioctyl phosphate (TOF). It has a higher degree of compatibility with PVC than expected, although it should be rated as a secondary plasticizer. The low-temperature properties are excellent, but when used alone, processing stability is not too good. When used with primary solvent types, TOF shows a definite tendency to bleed. This spewing does not occur when it is used as the sole plasticizer.

Tricresyl phosphate also finds use as a "chemical type" plasticizer for nitrocellulose coatings.



Plasticizers impart flexibility to the vinyl film and sheeting used in the manufacture of these raincoats and facilitate fabrication. (Photo, Merckon Co.)

Triphenyl phosphates are excellent plasticizers for the cellulose esters while tributoxyethyl phosphate is used for low-temperature purposes with some synthetic rubbers. Considerable amounts of phosphate esters are consumed in such other applications as hydraulic fluids, lubricants, gasoline, and beverages.

Adipates, azelates, and sebacates

Dibasic acid esters are presently limited to the adipates, azelates, and sebacates. Isosebacic acid is becoming available and will undoubtedly assume a fair part of this market if its price is sufficiently low. Due to relatively low compatibility and high volatility, the adipates are used primarily where cost is a factor. The azelates have been reported as having somewhat better resistance to bleeding under sunlight and heat than esters of the other two acids. The sebacates have generally been used where excellent aging with low-temperature resistance can be afforded in the end-product.

Production of dibasic acids is increasing and the next few years, if research continues at this pace, will undoubtedly see the introduction of many new acids. It is doubtful if this type of simple ester will ever assume a major

portion of the plasticizer market, although their use in making high-molecular-weight plasticizers may be important.

Esters of dibasic acids find their major use with PVC as secondary types. An adipate is finding use with the vinyl butyral, while a sebacate has been used with the same resin in some military items. Dioctyl sebacate and azelate are finding considerable use as lubricants for jet engines as are the adipates in extreme temperature range greases. Some small amount of adipates are used as dielectric fluids.

Maleic and fumaric acid esters have found almost no application as plasticizers. The citrates and related acids have shown promise, primarily because of lack of toxicity. These materials have good solvent power, color stability, and low-temperature resistance but tend to be high in volatility. One of the aconitate esters has found major application with the polyvinylidene chloride copolymers.

The monobasic acids have shown only special application to date. The benzoates, particularly benzyl-benzoate, have some use where a solid material is desirable. The aliphatic acid esters are limited largely to tetrahydrofurfuryloleate and methyl pentachlorostearate. Both these materials are secondary types, with stability limiting their use. The chlorostearate is one of the few nonflammable plasticizers that impart low-temperature resistance and can be stabilized electrically.

Epoxies

Epoxidized materials have established application as secondary plasticizers, their stabilizing action being of particular interest. These are usually made from mono-, di-, or tri-esters of the aliphatic monobasic acids.

Non-esters

A small portion of the plasticizer market is filled with non-ester materials. These are usually chlorinated aliphatic materials, petroleum distillates, ketones, ethers, sulfonamides, and nitro-aromatic compounds. They are primarily used to lower cost where some sacrifice can be made in such properties as low-temperature resistance or volatility.

Polymerics

During the last year, several producers have introduced polymeric types. These materials are distinguished by their lack of volatility. The problem in their development is to strike the proper balance between high-molecular-weight, fluidity, and compatibility. Purchasers of the finished article made of plasticized polymers are tending to specify limits that call for use of major amounts of the polymerics. More types of glycols are becoming available, which is encouraging the development of these polymeric types.

Polymeric types have found their major use with PVC. Some small amounts have gone into synthetic rubber.

Basic raw materials

The sources of acids, anhydrides, and alcohols are today well-established. Phthalic anhydride is produced in large volume. The major quantity of phthalate plasticizers is made by companies not producing the anhydride.

The alcohol supply is very free due to the large excess capacity now present in the oxo plants. This excess of capacity has fostered the development of other alcohols beside the octyl. So far, these alcohols from the oxo process have been selected by the ability to manufacture them from available crudes. Competition will undoubtedly force the production of alcohols selected primarily by their properties in the final plasticizer.

The dibasic aliphatic acid situation is changing rapidly. In the last few years a dependable source of azelaic acid has increased the use of azelate esters. Commercial production of isosebacic acid may cause a general price reduction in the dibasic acids. Very probably, other dibasic acids will become available quickly.

Future trends

One large future use of plasticizers may be with resin which cannot be plasticized at the present time. Development of new plasticizers or of new polymers may make this possible.

The plasticizer market will probably grow directly with the polyvinyl chloride market. The tendency will be to make higher-weight plasticizers, which may cause an increase in the ratio of plasticizer to resin. Foam and plastisol applications use increased amounts of plasticizer and will undoubtedly grow rapidly.

Major changes in plasticizer production depend on the industry's ability to introduce materials with increased molecular weight and fluidity. To obtain high weights by use of polymeric structures will probably not be possible, as fluidity depends on the randomness, or lack of regularity, in the structure. This was first indicated in the patents covering sebacic acid polyesters. Consequently, the use of directed esterifications may be of major importance.

A growing application of many plasticizers is as functional fluids for use as lubricants and as pressure and power transmitter liquids. Future requirements for these applications somewhat parallel those for plasticizer use.

References

Consult the Subject Index for additional information on plasticizers. See also the Plasticizers Chart. For sources of plasticizers, see the Directory Index, p. 1018.

"Analysis of plasticizer production in 1955," by H. I. Armstrong, P. W. Spink, and W. F. Waychoff, MODERN PLASTICS *34*, 144 (Oct. 1956).

"Aryl phosphate plasticizers in modern plastics processing," Plastics (London) *21*, 289 (Oct. 1956).

"Volatility of vinyl plasticizers," by W. J. Frissell, Ind. Eng. Chem. *48*, 1096 (June 1956).

"Epoxy resins as plasticizers and stabilizers for vinyl chloride polymers," by L. P. Witnauer, H. B. Knight, W. E. Palm, R. E. Koos, W C. Ault, and D. Swern, Ind Eng. Chem. *47*, 2304 (Nov. 1955).

"New method for determining phthalate esters in propellants," by J. Grodzinski, Analytical Chem. *27*, 1765 (Nov. 1955).

Solvents

BY JOHN W. WYART* and N. G. BAKER*

RECENT DEVELOPMENTS

Ethyl amyl ketone (Shell Chemical Corp.), a new high-boiling lacquer solvent, is now available in unlimited tank-car quantities. EAK is a better solvent for nitrocellulose than any other high-boiler commonly used. It is also used in vinyl coatings and as a starting point for chemical syntheses.

Tetrahydrofuran (Du Pont), a furfural derivative produced from one of the chemicals used in making nylon, is an excellent solvent for high-molecular-weight polyvinyl chloride resin and vinylidene chloride copolymers. Its principal use at present is in a topping coat for coated fabrics. A top coating with high-molecular-weight resin dissolved in THF will help eliminate the problems of crocking, blocking, migration, and marring. Another growing use for THF is in vinyl chloride adhesives where high speeds are necessary. Use of THF in cast vinyl film is still in the development stage. If successful, it may make possible the use of high-molecular-weight resins for cast film and may lower cost because of fast production.

A new thickening agent (*Viscotrol A*, Ferro Corp.) imparts thixotropic body to polar, nonpolar aromatic, and aliphatic solvents, as well as to non-solvent-containing liquid resins and plasticizers. Its ability to body organic liquids is not affected by phenols, polar solvents, water, and slightly acidic or basic components. It will maintain uniform viscosity over long periods of aging.

A liquid defoamer (*Surfynol 104A*, Air Reduction Chemical Co.) is recommended by the manufacturer for use in aqueous systems where foaming is a process problem, or undesirable in the end use. This company markets two other defoamers (*Surfynol 102* and *Surfynol 104-E*).

Solvents are selected from the broad category of industrial chemicals because of a specific property—their ability to dissolve other substances. In a sense, they can be considered as processing agents whose function is to facilitate the use of a solid substance for some particular application.

As these solvents are selected from a large field of chemicals, they often serve multiple functions. In addition to their solvent uses, they can be used as intermediates for preparation of other chemicals, or to supply certain physical properties to a mixture of ingredients. Some applications in which solvents are used other than for their dissolving actions are in extraction processes, concentration of pharmaceutical products, ore flotation, dry cleaning, automobile antifreezes, and hydraulic fluids, among others. A major use for solvents, however, continues to be as processing agents in dissolving resinous substances for the coating and adhesive industries. The textile industry also uses large quantities of organic solvents, particularly in the spinning solutions for cellulose acetate fibers.

* Celanese Corp. of America, 180 Madison Ave., New York, N. Y.

Recent Developments and References were prepared by the editors.

Development

The modern solvent industry started with the fermentation process developed during the first World War for production of acetone and butanol. Acetone was urgently needed for the war effort and, consequently, large facilities were erected for its production. Since butanol was a co-product of the process, it quickly became a surplus item.

For every pound of acetone, 2 lb. of by-product butanol were also produced. The growth which the plastics industry has witnessed is related to this butanol surplus.

In an effort to develop an outlet for this surplus, it was reacted with acetic acid to produce butyl acetate which was found to be an excellent solvent for cellulose nitrate.

Cellulose nitrate, when it was dissolved in butyl acetate and modified with resins, produced a quick-drying, attractive, tough, and durable substitute for paint and varnish needed by the automotive industry. This was the start of volume lacquer usage. Automotive production, which had previously been bottlenecked due to the slow drying properties of the paints previously used, was increased considerably. It was not long before other industries followed the lead of the automotive industry. Artificial leather utilized the new lacquer coating. The paper and furniture industries also began to finish their products with it. With this beginning, it was not long before other means than the fermentation of starch and sugars were used to produce butanol and other solvents for the new coatings industry.

Fermentation is still used as a means of manufacturing solvents. Some ethyl alcohol is produced from the fermentation of grain and black strap molasses and some butanol and acetone are also produced by fermentation. By and large, however, the solvent industry has come to depend on petroleum and coal by-products as a source of raw materials rather than such agricultural products as grain, molasses, corn, etc. Solvents that are manufactured by synthetic methods from these hydrocarbon products are more stable in their price structure than solvents manufactured from agricultural products. These latter types of solvents show wide price

TABLE I: Solvent production statistics[1]

Solvent	Solvent production, in million lb. 1940	1945	1950	1955
Acetone	202	349	482	538
Butyl alcohols	165	225	323	475
Butyl acetate (90%)	87	67	77	82
Ethyl acetate	75	106	92	85
Ethyl alcohol	1060[2]	2310	1090	1214
Ethyl ether	22[2]	76	38	69
Ethylene glycol	140	205	519	888
Halogenated hydrocarbons	—	1523	2089	3494
Isopropyl alcohol	220	490	866	854
Methanol	159	493	915	1343

[1] Source: U. S. Tariff Commission
[2] 1941 figures

fluctuation as their raw materials alternately become scarce or are in oversupply.

Synthetic production

The first step toward synthetic production of solvents came when the hydrogen and carbon dioxide by-products of fermentation were utilized for the preparation of methanol. In addition to its solvent uses, this alcohol is widely used in automobile antifreezes and as an intermediate for the production of formaldehyde.

Formaldehyde reacted with phenol and urea led to a whole series of new plastic materials which could be utilized in solvent solutions as coatings. It can be seen that the tremendous growth of the coating industry in general is closely intertwined with the growth in solvent production. This came about not only because of the processing improvements in coating application due to the availability of new solvents, but also by the utilization of these solvent materials as chemical intermediates for production of new resins and plasticizers. These in turn prompted the development of new solvents for their processing.

Oxygenated solvents

The volatile polar liquids such as the ketones, esters, glycol-ethers, etc., are of considerable importance in the coatings industry. These solvents are needed to disperse and dissolve the more difficult soluble macromolecular substances.

Esters: The original nitrocellulose solvents were butyl, ethyl, and amyl acetate. In 1955, more than 170 million lb. total of these three solvents were produced, primarily for the coatings industry.

Esters, of which the acetates represent the only commercially important members, are produced by reacting commercial alcohols with acetic acid or anhydride. In some cases, esters are produced as by-products in an ester interchange reaction, or by ester hydrolysis in the presence of alcohol. Methyl acetate, for example, is obtained as a by-product from the hydrolysis of polyvinyl acetate to polyvinyl alcohol. Almost all of the lower-priced alcohols are esterified for use as active solvents for resinous materials. Therefore, as more alcohols are made commercially available, the number of esters available will also increase.

Alcohols: Ethyl alcohol is the most important member of this class of chemicals. It is used as a solvent for shellac and various other resins, as a latent solvent for nitrocellulose, and an intermediate for a great many organic compounds. Ethyl alcohol is still produced in quantity by the fermentation of molasses and grain. In the last few years, however, synthetic material has made heavy inroads into the fermentation alcohol market. The quality of the synthetic product is equal to that of the fermentation grade.

Methanol is produced primarily by direct oxidation of hydrocarbon, although some wood distillation is still carried on. This alcohol is an excellent solvent for nitrocellulose, ethyl cellulose, natural and synthetic resins, etc. It is the most active of the aliphatic alcohols in solvent power; however, its industrial application is restricted somewhat by its high toxicity and its volatility. Methanol finds extensive use as an intermediate, principally for the production of formaldehyde. Both normal propyl and isopropyl alcohols are produced by hydrocarbon oxidation, with the latter alcohol assuming the greater importance. Isopropyl alcohol is produced in the greatest quantity of any alcohol except ethanol. It is used widely as a latent solvent in nitrocellulose lacquers. Its properties are similar to those of ethanol.

Butyl alcohol: All four isomers of butyl alcohol are produced commercially, with normal butyl alcohol finding widest application as a solvent. This alcohol is produced synthetically by the aldol condensation of acetaldehyde.

Higher alcohols: Amyl, hexyl, and octyl alcohols, and alcohols of even greater carbon chain length are produced commercially. Alcohols higher than 6 carbons (hexyl alcohol) are not frequently used as solvents due to their low volatility. These alcohols find widespread use as intermediates for plasticizers where low volatility is required.

Ketones: These chemicals have come into widespread use as solvents for resinous materials. Three are of great commercial importance—acetone, methyl ethyl ketone, and methyl isobutyl ketone. Acetone is the most important member of the group. It is produced in great quantities by oxidation of isopropyl alcohol. Acetone is an excellent solvent for nitrocellulose and most other cellulose resins although somewhat volatile for coating needs.

Methyl ethyl ketone is produced from secondary butyl alcohol. As the second member of the aliphatic ketone series it is less volatile than acetone and hence widely used in coating formulations. Methyl isobutyl ketone contributes flow to lacquers and is a good blush retarder.

Function of a solvent

Most of the resins available in industry for coating purposes are hard and brittle substances.

Others are less hard and some are even soft tacky materials. All of these have to be made fluid and the particles welded together to form a continuous film before it can be considered a coating.

Provided the chemical structure of the resin is not altered, this fluid workable state can be achieved by heating the resin or by dispersing it in a solvent. These properties exist only while the heat is applied or while the solvents are in association with the resin. Removal of either causes the resin to revert to its original unworkable state. In this respect, a solvent differs from a plasticizer. An important difference in the use of plasticizers and solvents, of course, is that solvents are always used in fairly large amounts to produce a liquid material, whereas plasticizers are used in smaller quantities to produce a flexible yet still solid product.

In order to understand better the behavior of solvents and resin, we might consider the structure of a resin before and after the addition of a solvent. A resin appears to be a three-dimensional network of macromolecules. Each of these molecules has attracting points along its chain. These attracting points can attract each other, thereby setting up secondary forces of attraction between resin macromolecules. If these attracting centers are many and strong, the forces of attraction will be such that a very close-packed, rigid structure will result. Such a resin will be hard and brittle. If, however, there are few attracting centers, and if they are relatively weak, then a flexible material will result. These bonding forces between molecules are actually equilibrium forces, for if we heat or cool the resin we will affect the properties, thereby indicating that motion resulting from freedom in the mass is still possible. It can be said that an aggregation-disaggregation equilibrium exists between the molecules.

If a solvent is introduced into the resin, its molecules, being much smaller and more mobile, will move in and around the molecule of the resin. This movement in and around the resin molecule causes a physical separation by actual breaking of the secondary valence bonds. In addition, since the solvents are polar materials, they will be attracted to the attracting center on the resin macromolecule, and will compete with other resin macromolecules for these centers. This solvation is also an equilibrium process and the solvent molecule after momentary attachment is replaced by another solvent molecule or another resin macromolecule attracting center. Thus, there is a solvation-desolvation equilibrium. There are then two competing equilibria, solvation-desolvation of the solvent molecules and aggregation-disaggregation of the resin macromolecules. Obviously, a change in equilibrium in favor of solvation-desolvation would increase functionality.

Cellulose nitrate coatings

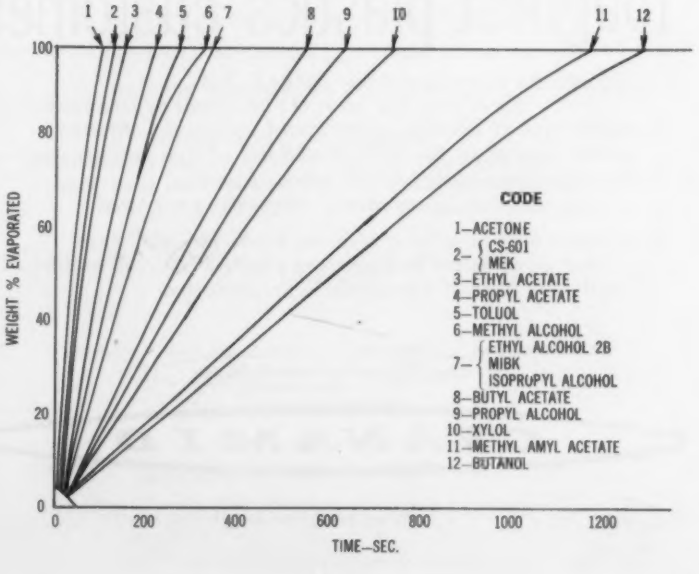
Cellulose nitrate, in order to be used as a coating material, is dissolved in a mixture of solvents. This mixture is called the thinner and is composed of liquids that have varying degrees of solvent power for the polymer. They are broadly classified as active solvents, latent solvents, and diluents. The liquids described as active solvents actually dissolve the polymer. Most of these are polar compounds containing oxygen-bearing groups. Aliphatic esters and ketones are the active solvents most commonly employed. Latent solvents are always alcohols. They do not promote solvation of the polymer by themselves. However, they usually add to the solvating effect when used in conjunction with the active solvents. Diluents are used to dilute and cheapen the thinner and are usually aliphatic and aromatic hydrocarbons.

Various tests have been developed to determine the effectiveness of a thinner as a dissolving agent. These indicate, in a practical sense, the application characteristics of such solutions. The degree of solution is indicated by the viscosity, since it is this property that indicates whether the lacquer is in a proper state of fluidity. The degree of fluidity dictates the method of application, e.g., spraying, brushing, or other techniques.

Second in importance is the tolerance of the lacquer for hydrocarbon diluents. This indicates whether the thinner has been formulated in the most economical manner. A high dilution ratio, for instance, would indicate that the thinner could stand further dilution.

Since these coatings dry by solvent evaporation, the rate of this evaporation is all-important in determining the properties of the film. Practical tests have been de-

Fig. 1: Evaporation rate curves of lacquer solvents and diluents





CYANAMID

Dyes to please the toughest plastics customer!

Out of the many dyes made in the U.S.A., only a very few meet the chemical and physical requirements of plastics. American Cyanamid Company —past master in the science and art of dye manufacture— offers dyes formulated for all types of plastic products where dyes are used.

For expert help in solving coloring problems—for dyes that work better and produce plastics that sell better— call your nearest Cyanamid representative.

• Oil Soluble Dyes • Nigrosines • Spirit Soluble Dyes • Specialties
Calco Dyes for the Plastics Industry

CYANAMID

Calco®
The Symbol for Quality Dyes

AMERICAN CYANAMID COMPANY, DYES DEPARTMENT
Bound Brook, New Jersey

North American Cyanamid Limited • Montreal • Toronto

veloped to indicate whether a thinner is evaporating properly. Determination of blush resistance of a lacquer often indicates whether or not a thinner is too fast. Blush resistance is determined by observing the degree of relative humidity at which precipitation of the film occurs. This is a function of the temperature of the film's surface as well as of the relative humidity. Therefore, a thinner that dries too rapidly will produce too great a cooling effect at the surface.

In formulating cellulose nitrate lacquers, it is generally desirable to use solvents that combine good solvent power with relatively slow evaporating properties. It is not usually easy to do this. Solvents that are most effective in reducing viscosity, such as ethyl acetate, methyl ethyl ketone, etc., also evaporate most rapidly.

Standard cellulose nitrate lacquer thinner formulations are designed to evaporate in a fairly constant manner. Thus, a graph of the evaporation rate would approach a straight line. These thinners are usually balanced with equivalent parts of fast-, medium-, and slow-evaporating solvents and diluents.

There are two major deviations from this type of formula. One is the thinner used with hot-spray lacquers. In these formulations, heat is used to aid viscosity reduction, since cellulose nitrate solvency is also a function of the temperature. Medium- and slow-evaporating solvents are used in these thinners with very little emphasis on fast evaporators.

The other deviation is classified as the "high-build thinners." In this type of formulation, only fast-evaporating solvents that are also good viscosity-reducing materials are used in conjunction with slow solvents, with little emphasis being placed in the medium boiling range. Both of these lacquers find wide acceptance in fields where the extra equipment necessary for their application is available.

Vinyl resins

Vinyl resin solutions differ from conventional nitrocellulose solutions although many of the same solvents and diluents are used in

both types. Most of the vinyl resins used for solution coatings are copolymers of vinyl chloride and vinyl acetate, with the vinyl acetate constituting about 17% of the product.

Solution coatings based on vinyl resin differ in several important ways from the conventional pyroxylin lacquers. They are less susceptible to blushing, and show greater resistance to certain solvents and to weathering. In addition, they show limited compatibility with modifying resins, possess rather poor adhesion at air-drying temperature, and have a tendency toward orange peel.

The vinyl resins used for solution coating are usually dissolved in ketones and diluted with aromatic hydrocarbon. Since blushing is not a factor and since the films are usually baked, fast-evaporating solvents can be used. Formulations are simple, compared to the highly-modified nitrocellulose lacquers. Usually, one or two vinyl copolymers and one or two solvents constitute a formula.

The solvent technology of vinyl resins also differs considerably from nitrocellulose. Solutions of high resin concentration tend to gel, as well as those in lean, thinner mixtures. These gels are not generally reversible, as are nitrocellulose gels, which merely require addition of solvent for the resin to be redissolved.

Ketones are the preferred solvents; however, nitroparaffins are also used as are some cyclic oxides. Aromatic hydrocarbons are generally preferred as the diluents. Alcohols are usually avoided in formulations containing standard vinyl copolymers.

Current developments

Developments in coating systems in which solvents are employed continue to arouse the interest of formulators. Of more recent vintage are the isocyanate lacquers. Basically, these coatings are formulated by dissolving a suitable polyalcohol and a polyisocyanate in suitable inert solvents. Inert solvents in this case are those which will not preferentially react with the isocyanates. The lower alcohols and basic solvents are not used, and solvents



CYANAMID

Quality Pigments for Plastics

Specify Cyanamid pigments for every coloring requirement in plastics... and you can be sure of uniform high quality and top pigment performance.

Ultramarine Blues
Phthalocyanine Blues and Greens
Chrome Yellows, Oranges, Greens
Valencia Orange
Iron Blues
Organic Toners and Lakes
UNITANE® Titanium Dioxide
—Anatase and Rutile Types

Color is the difference

CYANAMID

AMERICAN CYANAMID COMPANY
PIGMENTS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

BRANCH OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

Certain Qualities make STRONG APPEAL



We are talking about those important qualities in so many products made of —

PLASTICS

COLORS for Instance-

Brilliance and permanence with precision matching of tones add the lure that helps sales appeal . . . Colors dispersed in plasticizers or plastics for easy incorporation into compounds — to save on production costs . . .

PLASTICIZERS

★ POLYCIZER DBS — (Dibutyl Sebacate)
★ POLYCIZER DBP — (Dibutyl Phthalate)
★ POLYCIZER 162 — (Dioctyl Phthalate)
★ POLYCIZER 332 — (Dioctyl Adipate)
★ POLYCIZER 532 — (Octyl Decyl Adipate)
★ POLYCIZER 562 — (Octyl Decyl Phthalate)
★ POLYCIZER 632 — (Didecyl Adipate)
★ POLYCIZER 662 — (Didecyl Phthalate)
★ POLYCIZER 662-BPA — (Electrical grade of 662)
★ CELLUFLEX 179C — (Tricresyl Phosphate)
★ CELLUFLEX 112 — (Diphenyl Cresyl Phosphate)

★ STAN-TONE MBS — Colors plastic dispersed in masterbatch form. Standardized in color intensity for precision color matching, cleaner compounding.

★ STAN-TONE PEC — Polyester paste colors. Pigments selected for maximum heat and light stability. Custom-matched to color requirements, in polyester resin.

★ STAN-TONE Paste — Color dispersed in plasticizer for organosol, plastisol and calendered vinyl resins.

★ STAN-TONE GPE — Colors dispersed in polyethylene, for polyethylene, rubber and vinyls.

★ STAN-TONE Dry Colors . . .

STABILIZERS

We offer a complete line of stabilizers for balanced heat and light stabilizing for all polyvinyl chlorides and their copolymers . . . In paste, powder and liquid forms for long outdoor aging, for excellent light and heat stability, for non-toxic packaging films, for preserving color brightness in many plastic materials.

Write for complete technical data on any products.

HARWICK STANDARD CHEMICAL CO.

THROUGH ITS OFFICES IN AKRON, BOSTON, CHICAGO, TRENTON, ALBERTVILLE, ALA.

containing reactive materials (water, amines, alcohols, glycols, or acids) should be avoided. Some of the pure esters such as ethyl, propyl, and butyl acetate find use as solvents in these coatings.

Polyurethane lacquers, although slow in finding popularity in this country, show promise in such applications as weatherproofing for textiles and wood; impregnants, particularly for armature windings; and corrosion-resistant coatings for metal.

Much effort has been directed toward development of systems that would obviate the need for organic solvents as a means of controlling the fluidity of resinous materials. Various mechanical systems have been devised to permit the use of heat as a fluidizing agent, and emulsion technology, in which water is the fluidizing medium, has made great strides in development. However, many types of coating application would not be feasible except from an organic solvent medium. While the physical disadvantages of solvents (toxicity, flammability, etc.,) promote investigation of substitutes, the technological advantages gained by their use should permit them to maintain their commercial importance for some time to come.

References

Consult the Subject Index for additional information on solvents. For sources of solvents, see Directory Index, p. 1018.

"Technology of solvents and plasticizers," by A. K. Doolittle. 1954. New York: John Wiley and Sons, Inc.

"The handbook of solvents," by L. Schefland and M. Jacobs. 1954. New York: D. Van Nostrand Co., Inc.

"Chemical analysis of industrial solvents," by M. B. Jacobs and L. Schefland. 1953. New York: Interscience Publishers, Inc.

"Non-aqueous solvents," by L. F. Audrieth and J. Kleinberg. 1952. New York: John Wiley and Sons, Inc.

"Industrial solvents," by I. Mellan. 1950. New York: Reinhold Publishing Corp.

"Solvents," by T. H. Durrans. 1950. New York: D. Van Nostrand Co., Inc.

WITCIZER® PLASTICIZERS

Noted for clarity, compatibility, and low odor

METALLIC STEARATES

For "plastigels," internal lubrication, heat and light stabilization

STAYRITE® STABILIZERS

Especially developed for vinyl stabilization

WITCOBLAK® CARBON BLACKS

Grades for every tinting need

WITCARB®
(Precipitated Calcium Carbonate)

Low-cost inert filler and extender for polyester resins

Helping you PINPOINT your plastics requirements

Need chemicals with that "tailor-made" quality for your plastics manufacturing processes? Then join the ever-growing number of manufacturers who are turning to Witco. For Witco offers a broad selection of chemicals to fill your most exacting requirements. The plastics industry has found that Witco products have dependable uniformity maintained by the strictest quality control in Witco's own plants.

Prompt and effective assistance from our technical service laboratories is available at all times.

Send today for complete information and samples.

WITCO CHEMICAL COMPANY

122 East 42nd Street, New York 17, New York

WITCO

37 Years of Growth

Chicago • Boston • Akron • Atlanta • Houston
Los Angeles • San Francisco • London and Manchester, England

WITCO 77-86

Coupler for urethane foams

FOMREZ 50

Polyester for urethane foams





THERE'VE BEEN SOME CHANGES MADE...

...IN PLASTIC COLORING METHODS, TOO!

Today's streamlined approach to plastic coloring is with PMS DRY COLORANTS. Saves paying a premium for compounded thermoplastics . . . ends inventory headaches . . . assures perfect color results with any thermoplastic. Write for detailed brochure.

PLASTIC MOLDERS SUPPLY CO., INC.

74 South Avenue • Fanwood, N. J.

BRANCH OFFICES

1730 Columbus Ave.
Sandusky, Ohio
A. K. Van Cleet, Mgr.
Phone Sandusky 8754

Plastic Molders Supply Co., Inc.
Worcester, Mass.
H. S. Riggs, Mgr.
Phone Pleasant 5-1088

CHICAGO AREA MOLDERS: PHONE ENTERPRISE 4615, FOR OVERNIGHT DELIVERIES

DISTRIBUTORS FOR American Cyanamid, Polyester Resins; Celanese Corporation, Polyester Resins and Catalyst, Specialty Chemicals Company, Methyl Ethyl Ketone Peroxide (60), and Resin Rinse.

AUTHORIZED PMS DISTRIBUTORS

Color Paste Dispersions for Polyester and Epoxy Resins

B & B DISTRIBUTING CO.
3707 N.W. 49th Street
Miami 42, Florida

KRISTAL KRAFT
900 Fourth Street
Palmetto, Florida

CADILLAC PLASTIC & CHEMICAL
15111 Second Avenue
Detroit, Michigan

ALLIED RESIN PRODUCTS CO.
216 Milk Street
Boston, Massachusetts

PLAS-TEX CO., INC.
2813 Crockett Ave.
Fort Worth, Texas

BOATEX FIBERGLASS CO.
325 Brookline Street
Needham, Massachusetts

FIBERLAY INC.
1158 Fairview Avenue N.
Seattle 9, Washington

WALDOR ENTERPRISES LTD.
7498 19th Avenue
Ville St. Michel,
Montreal, Canada

PARK-HANNESSON LTD.
55 Arthur Street
Winnipeg 2, Man. Canada

EXPORT AGENTS
INTERPLASTICS CORP.
120 East 56th Street
New York 22, N.Y.

How to give your plastics the beauty of

PEARL



with

NACROMER®

Incorporated into any thermoplastic resin, or as a coating on any plastic, Nacromer adds a distinctive pearl-like lustre to any product at amazingly low cost. Either method produces excellent results—unique effects impossible to achieve any other way.

Incorporated into the plastic itself (polystyrene, polyethylene, polyesters, acetates, vinyls, etc.) Nacromer provides a pearlized effect with no changes required in your usual molding or casting process. Nacromer is easily mixed into your plastic by hand, in a Banbury, or on the rolls . . . or your compounder can supply you with ready-mixed resins containing Nacromer.

As a coating, you merely add Nacromer to your present coating material and apply by your usual method (spray, brush, or dip). No additional finishing operations are required. The addition of transparent dyes makes possible unlimited colors and effects.

Either way you use it, Nacromer will make an immediate improvement in the sales appeal of your products. Mail the coupon below for more complete information and demonstration samples.

the *Mearl* corporation

"World's Largest Producers of Pearl Essence"

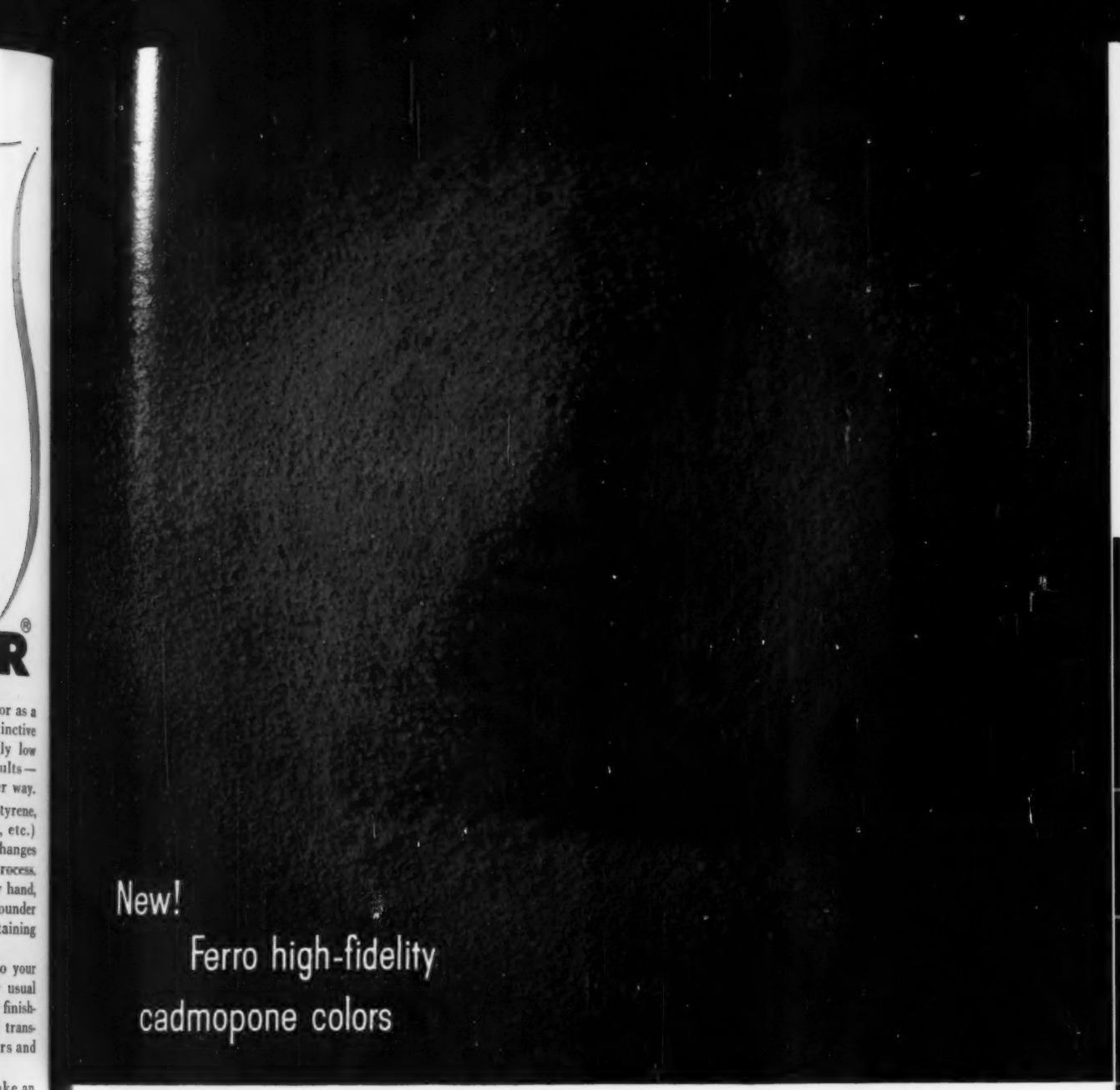
THE MEARL CORP., 124 East 40th Street • New York 16, N. Y.

Please send more information about Nacromer.
☐ We want to incorporate it into _____.
☐ We want to use it as a coating.

Name _____

Company _____

Address _____



Easier to disperse! Excellent heat and light stability!

Now, Ferro has developed a new type of reduced cadmium pigment that is lighter and fluffier for easier dispersion. New Ferro CADMOPONES are highly resistant to heat, light, acids and alkalies. They give you permanent, nonbleeding and fade-resistant colors for all plastic materials.

CADMOPONE colors are perfect for dry coloring clear resins in your own plant. This simple process eliminates waste, cuts the cost of raw materials and helps you give faster delivery on special jobs. Ferro can supply you with technical data and suggestions for dry coloring the plastics you use.

If you use red, orange or maroon in your production, you can save time and money with New Ferro CADMOPONE colors. Their faster dispersion and stability cut rejects and improve quality. Write today for color chart and samples!

FERRO CORPORATION
Color Division
4150 East 56th Street • Cleveland 5, Ohio

5309 South District Boulevard, Los Angeles 22, California

Ferro Enamels (Canada) Ltd., Oakville, Ontario, Canada

Foreign plants in Argentina, Australia, Brazil, Chile, England, France, Holland, Japan, Mexico, South Africa

F-11886 Orange | F-11887 Orange-Red | F-11888 Red | F-11571 Maroon

Your ABC's for

INORGANIC COLORING

polystyrene

Recent developments in mold-making (i. e., pin-point gating), polystyrene in smaller sized granules or pellets, new injection molders equipped to mix clear polystyrene and color in the extruder, and new Ferro dry colors have all contributed to a quick, easy way for the polystyrene user to do his own coloring.

Write for new booklet which explains how. Also available, detailed sheets containing technical information on the use of Ferro colors with polystyrene.

polyolefin

This new high-density polyethylene resin is easily *dry colored* with Ferro pigments. Ferro has developed colors to match P. S. P. standards, as well as a line of special houseware colors for this resin.

Write for technical data sheets and procedures for dry-coloring polyolefin resins.

polyethylene

There is a trend to use polyethylene in fields where color is a necessity. The fast, easy dispersion of Ferro inorganic pigments makes them especially suitable for dry coloring this material.

Write for new booklet which gives all the facts. Technical data sheets on Ferro colors for polyethylene are also available.

nylon

A big difficulty in molding nylon is to find suitable colors that will stand up under the high temperatures required. After five years' research, Ferro has developed a line of nylon colors that is completely safe, workable and efficient.

Write for technical data sheets and new booklet which tell you how to use Ferro dry colors for nylon. A simple drum is the only equipment you need.

polyesters

Ferro paste colors are specially compounded for coloring polyester resins. They have been approved by resin users as well as the manufacturers.

A new booklet is now available to help you in polyester color work with Ferro paste colors. Write for it today.

epoxies

Ferro has just developed a new group of paste colors for use with epoxy resins for casting, laminating and potting. These pastes are concentrated to give you maximum color strength per dollar. An epoxy resin is used as the liquid medium to solve problems of incompatibility.

vinyls

Many dry colors are not adaptable to vinyl formulas because of the hardness of the colors, or because colors contain zinc or iron. Ferro dry colors produce a soft, non-specking color and colors may be selected that contain no zinc or iron.

New booklet points out advantages of dry coloring over color concentrates, and describes best method of dry coloring for calendering, extrusion, molding. Send for it, today.

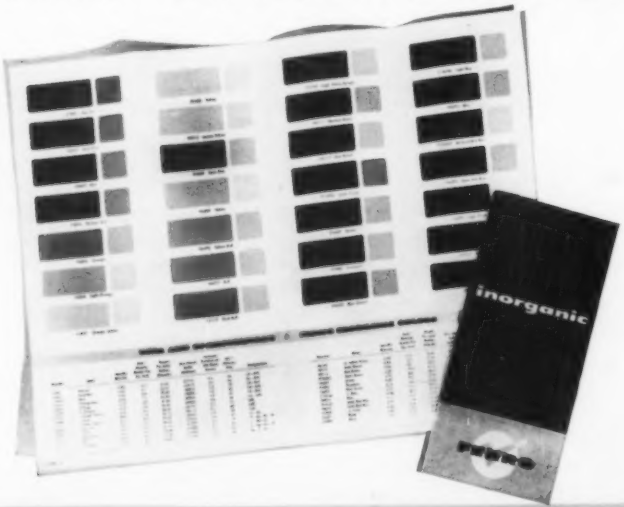
fluorothene . . . Kel-F . . . Teflon

Fabricated at temperatures up to 700°F., these fluorine-type resins require colors of high heat stability. In some instances, it is also necessary to pulverize the color-resin mixtures (in the case of Teflon, after cooling to sub-zero temperatures).

Write for new booklet which describes the techniques involved, also tells how to select Ferro colors for best results.

WRITE ALSO FOR THESE BOOKLETS:
Technique of Coloring Lucite and Plexiglas . . . Technique of Coloring Cellulose Acetate and Cellulose Acetate Butyrate

FERRO INORGANIC BASE PIGMENTS



it will pay you to specify colors by Ferro because . . .

- Ferro pigments are finely ground mixtures of inorganic materials calcined from 1200° to 2300° F. They blend readily; are easy to work; have a low bulking value.
- Ferro pigments are resistant to acids, alkalies, all weather conditions; are heat- and light-fast, and non-migrating.
- Ferro maintains a color-matching service. Any desirable color can be "tailored" to the vehicle designated by the customer.
- Ferro pigments are checked and then double checked under the customer's production conditions. When Ferro pigments leave our plant, they're "right"—ready for use.

write today for new combination Inorganic Color Chart and Data Sheet. Shows Ferro's 28 Base Colors with which almost any desired color match can be made.

FERRO

FERRO CORPORATION • *Color Division*

4150 East 56th Street • Cleveland 5, Ohio

5309 SOUTH DISTRICT BOULEVARD, LOS ANGELES 22, CALIFORNIA • FERRO ENAMELS (CANADA) LTD., OAKVILLE, ONTARIO, CANADA

Foreign companies in ARGENTINA • AUSTRALIA • BRAZIL • CHILE • ENGLAND • FRANCE • HOLLAND • HONG KONG • JAPAN • MEXICO • SOUTH AFRICA

ADM'S

Admex VINYL PLASTICIZERS

Nation Wide in Service

Industry Wide in Performance

ADMEX EPOXY PLASTICIZERS

Admex 710 Double duty . . . serves as both plasticizer and stabilizer. For compounding film and sheeting, plastisol and organosol dispersions and extruded products. Insures color uniformity of consumer products when exposed to constant sunlight and high temperatures.

Admex 711 Resistance to migration and exudation exceeds any other commercially available plasticizer of its type. For film, sheeting, coated fabrics, floor tile.

Admex 744 For outstanding performance at temperature extremes. Provides low temperature flexibility. Contributes color stability to compounds requiring high heat processing.

Admex 745 A new low temperature plasticizer with low volatility and extraction features.

ADMEX POLYMERIC PLASTICIZERS

Admex 760 New pale colored polymeric having outstanding permanence and non-migration.

Admex 761 Versatile polymeric of low viscosity and with maximum extraction resistance.



Archer-Daniels-Midland

718 INVESTORS BUILDING
MINNEAPOLIS 2, MINN.

UVINUL®

400, 490, D49, M40

Permanently Prevent Deterioration and Discoloration caused by Ultraviolet Light

Versatile Uvinul absorbers and stabilizers have many profitable applications to the plastics industry. They can be incorporated into solid plastics and protective coatings to permanently prevent deterioration and discoloration caused by ultraviolet radiation. They are also effective as stabilizers for organic liquids and aqueous solutions.

The Uvinul stabilizers offer a full range of compatibilities and ultraviolet protection permitting users to select the product best suited for their needs. Write today for more detailed information.

ANTARA gaf

From Research to Reality

ANTARA CHEMICALS
A SALES DIVISION OF
GENERAL ANILINE & FILM CORPORATION
435 HUDSON STREET · NEW YORK 14, NEW YORK

SALES OFFICES: New York • Boston • Providence • Philadelphia • Charlotte • Chattanooga • Chicago Portland, Ore. • San Francisco • Los Angeles. IN CANADA: Chemical Developments of Canada, Ltd., Montreal

Kentucky Color

AND CHEMICAL COMPANY, INC.

DRY COLORANTS *for* PLASTICS

CADMIUM YELLOW TONERS
CADMIUM RED TONERS
PHTHALOCYANINE BLUE
PHTHALOCYANINE GREEN
ORGANIC REDS
ALSO CHROMATES
Color Matching Service

Offices and Agents in Principal Cities

Main Office and Plant
LOUISVILLE 12, KENTUCKY

for superior
thermosetting resins...

SPECIFY
DU PONT FORMALDEHYDE

and you'll get:

CONSISTENT TOP QUALITY
DEPENDABLE ON-TIME DELIVERY
DU PONT TECHNICAL SERVICE
SELECTION OF CONTAINERS
CHOICE OF STRENGTHS

Du Pont has the quality products, equipment and trained personnel to fill your particular formaldehyde needs. For quality formaldehyde products, delivered on schedule, contact the Du Pont district office nearest you.

- 50% (by weight) Formaldehyde L.M. (low Methanol). In tank cars and tank trucks.
- 45% (by weight) Formaldehyde L.M. In tank cars and tank trucks.
- 37% (by weight) Formaldehyde L.M. In tank cars and tank trucks.
- 37% (by weigh:) Formaldehyde U.S. Pharmacopeia In tank cars and tank trucks, drums, carboys, bottles.
- Paraformaldehyde 95% (minimum strength) powder or granular. In bags and fiber drums.
- Hexamethylenetetramine Tech. powder or granular. In bags and fiber drums.
- Hexamethylenetetramine Tech. FF (with anti-caking agent) powder or granular. In bags or fiber drums.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
... through Chemistry

ELECTROCHEMICALS DEPARTMENT
Formaldehyde Products Division

E. I. DU PONT DE NEMOURS & CO. (INC.)
Wilmington 98, Delaware

DISTRICT AND SALES OFFICES

Baltimore 2	321 Fallsway	PLaza 2-2862
Boston 10	140 Federal St.	HAncock 6-1711
Charlotte 1	427 W. Fourth St.	FRanklin 5-5561
Chicago 30	7250 N. Cicero Ave. Lincolnwood	INdependence 3-7250
Cincinnati 2	2412 Carew Tower	PArkway 1-5253
Cleveland 20	11900 Shaker Blvd.	LOngacre 1-1580
Corpus Christi*	1502 N. Tancahua St.	TUlip 3-8464
Dallas 10*	3306 Borich St.	HAmilton 1-7668
Detroit 35	13000 W. Seven Mile Rd.	UNiversity 4-1963
Fort Worth 1*	2802 S. Main St.	WAlnut 7-8472
Houston 7*	2812 Center St.	CApital 7-4132
Kansas City 20*	Guinotte and Mich. Aves.	VIctor 2-6240
Los Angeles	P.O. Box 70, El Monte, Calif.	CUmb. 3-2761
New Orleans 18*	Maple & Leake Aves.	UNiversity 1-8191
New York 1	350 Fifth Ave.	LOngacre 3-8440
Odessa*	125 S. Grandview Ave., Odessa, Texas	FEderal 7-7323
Oklahoma City 1*	1700 W. Grand Ave.	CEntral 2-1351
Philadelphia	308 E. Lancaster Ave., Wynnewood	TRinity 8-2700
San Francisco 4	111 Sutter St.	EXbrook 2-6230
Tulsa 3*	26 N. Guthrie St.	LUther 5-1251
Wichita 1*	2041 N. Mosley Ave.	AMherst 7-6293

*Barada & Page, Inc.

Export Division, Du Pont Building, Wilmington 98, Delaware

CABOT

WHITE Pigments

improve plastics products and processes

Wollastonite

A unique mineral filler for polyester molding compounds; can be used at high concentrations without exceeding a practical working viscosity. It imparts to the compound

SMOOTH SURFACE
GOOD WHITE COLOR
HIGH DIELECTRIC STRENGTH
HIGH IMPACT STRENGTH WHERE NEEDED

Cab-o-sil®

A different silica with superior properties; prepared in a hot gaseous environment and not by the usual aqueous precipitation process. Surprisingly small quantities are required to effect startling improvements in plastics. Now being used as a

THICKENING AND GELLING AGENT
THIXOTROPIC AGENT
EMULSION STABILIZER
TRANSPARENT EXTENDER
ANTI-BLOCKING AGENT

Write for bulletins, technical information,

Minerals & Chemicals Division

CABOT

Carbon BLACKS

give maximum jetness and protection against weathering at low cost, in all types of plastics...

Carbolac® 2

Maximum jetness in polyvinyls and nitrocellulose systems

Supercarbovar®

Excellent pigment for obtaining jet blackness in polyvinyl chlorides and similar type materials

Monarch® 71 Black Pearls® 71*

Recommended where increased blackness is required. Slightly higher in cost than Monarch 74.

Monarch® 74 Black Pearls® 74*

Standard color for use in polyethylene. Offers good protection against weather and ultraviolet degradation

Monarch® 81 Black Pearls® 81*

Maximum jetness at low cost

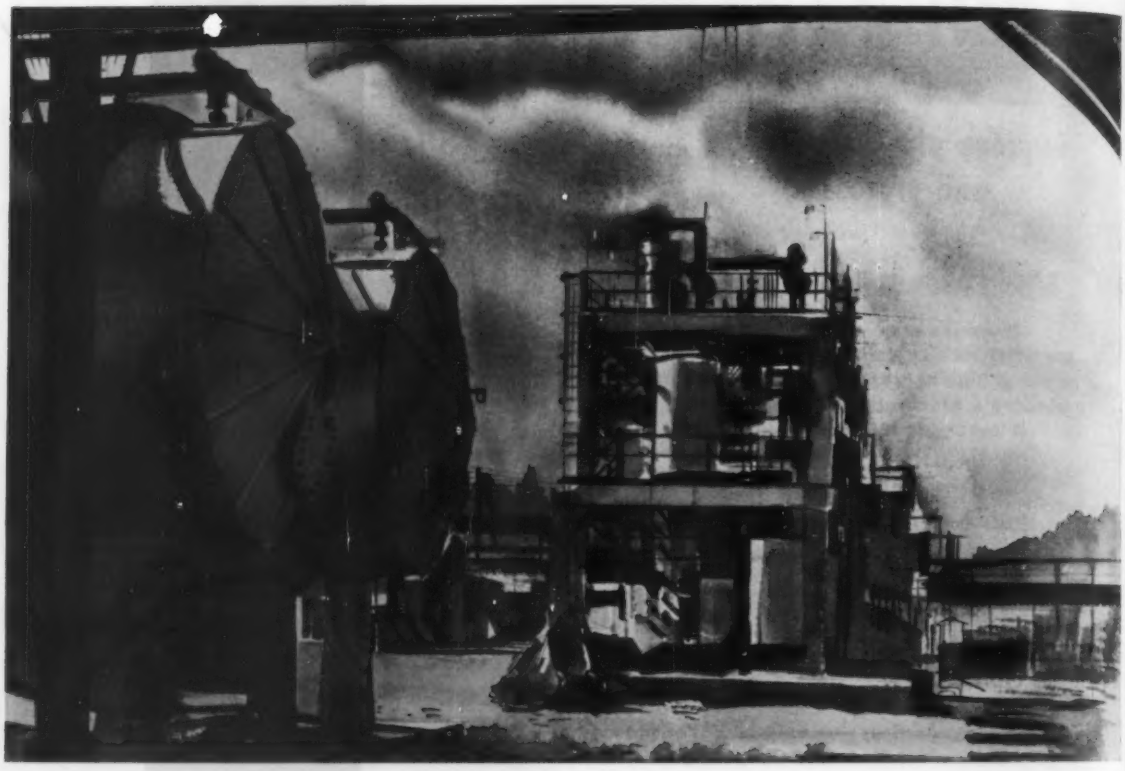
* *Pelleted Form*

Special Blacks Division

GODFREY L. CABOT, INC.

77 FRANKLIN STREET, BOSTON 10, MASSACHUSETTS

From one dependable source . . .
a complete range of organic chemicals for the plastics industry



National Aniline is the leading supplier of organic chemicals for resins, plasticizers and plastics.

Our complete line of dibasic acids, anhydrides and related chemicals . . . already the broadest range available . . . answers the plastic industry's need for a diversity of basic materials.

Production facilities are ample to meet the constantly expanding volume. Continuing supply is assured from our long-established facilities at Buffalo, N. Y. and our ultra-modern plants recently constructed at Hopewell, Va. and Moundsville, W. Va.

Technical data and samples of the products described and listed here are available. We will be glad to quote prices and delivery.

National Aniline Allied Chemical

NACCONATES®
(Diisocyanates)

Urethanes are so versatile that the ultimate limits of their usefulness and their market potential have yet to be predicted. As major producers of diisocyanates, National Aniline is prepared to meet the foreseeable demand with integrated production from a new multi-million-dollar plant at Moundsville. Technical Bulletin I-17, supplements A to F and product data sheets are available on request.

MALEIC ANHYDRIDE
Tablets

National Maleic Anhydride tablets set the standard for the resin-chemical industry. They are uniform, easier to handle, quick-dissolving, essentially non-dusting and have few fines. Mixed car and truckloads are offered with Phthalic Anhydride, Fumaric and Adipic Acid. Comprehensive data on Maleic Anhydride is contained in our 58-page book, and we will gladly submit samples, specifications and prices.

PHTHALIC ANHYDRIDE

The standard of quality for the industry is set by National Phthalic Anhydride. Available in molten and flake form. Mixed car and truckloads are offered with Maleic Anhydride, Adipic and Fumaric Acid. Working samples sent on request.

NADONE*
(Cyclohexanone)

Fully-integrated production of the highest-quality cyclohexanone available! Produced at Hopewell by an advanced, direct, continuous process with a minimum purity of 99.0%, NADONE makes high-quality, light-colored resins. A sample will show you how good it is. Technical Bulletin I-19 gives properties, reactions and an inclusive bibliography.

ADIPIC ACID

Basic, non-captive production by an efficient, continuous process makes National Aniline a major supplier. National Adipic Acid analyzes at least 99.8% in purity and is light in color, low in iron. For complete product information request Technical Bulletin I-12.

NAXOL*
(Cyclohexanol)

Substantial basic production of this important secondary alcohol is now on stream and can be quickly expanded to meet any foreseeable need. Two types immediately available: NAXOL (100% material) and NAXOL D (freezing point depressed). Working samples available. We will be glad to quote price and delivery on C/L and LCL quantities.

FUMARIC ACID

Produced at Moundsville and Buffalo by a direct process developed by National Aniline research, National Fumaric Acid is unequalled anywhere. 99.6% pure and free-flowing. Its absence of color makes it extremely useful for resins and plasticizers.

Mixed car and truckloads available with Maleic Anhydride, Phthalic Anhydride and Adipic Acid. Samples and quotations on request.

ε-CAPROLACTAM

This unusual 6-carbon chemical is in large-scale production at Hopewell. Ample supplies are available at an attractive price. We will gladly provide working samples and technical assistance leading to the development of new applications. Technical Bulletin I-14 describes known chemical reactions, suggesfed uses and bibliography.

*Trademark

Write for samples and data on

Aniline • Hexahydro Phthalic Anhydride
Tetrahydro Phthalic Anhydride • Nadic® Anhydride
(endo-cis-Bicyclo (2,2,1) -5-heptane -2,3-dicarboxylic anhydride)
Succinic Anhydride • m-Phenylenediamine
Succinic Acid • Malic Acid • Dodecenylsuccinic Anhydride
as well as our comprehensive line of
PLASTIC AND RESIN COLORS

NATIONAL ANILINE DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 RECTOR STREET, NEW YORK 6, N.Y. • HAnover 2-7300

Akron, Ohio, First Federal Savings Bldg. BLackstone 3-9324
Atlanta, Ga., 1216 Spring St., N. W. TRinity 6-8308
Boston 14, Mass., 150 Causeway St. CApitol 7-0490
Charlotte 1, N.C., 201-203 West First St. EDison 3-9221
Chattanooga 2, Tenn., 1203 James Bldg. CHattanooga 6-6347
Chicago 54, Ill., The Merchandise Mart MIchigan 2-1800
Columbus, Ga., Columbus Interstate Bldg. Columbus 7-4512
Greensboro, N.C., Jefferson Stand. Bldg. GReensboro 2-2518
Los Angeles 58, Cal., 4814 Loma Vista Ave. LOgan 8-2257
New Orleans 12, La., Carondelet Bldg. Raymond 7228
Philadelphia 6, Pa., 200-204 S. Front St. LOmbard 3-6382
Portland 9, Ore., 730 West Burnside St. Beacon 1853
Providence 3, R.I., 15 Westminster St. DExter 1-3088
Richmond 19, Va., 8 North Fifth St. Richmond 2-1930
San Francisco 4, Cal., 235 Montgomery St. YUkon 2-4840
Toronto 14, Can., 100 North Queen St. BEImont 3-6278

you save 3 ways with BROWN-ALLEN plasticizers



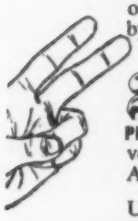
1 **Don't sacrifice quality in your vinyl formulations!** Don't use inadequate secondary plasticizers! Get a primary plasticizer—Polycon #40 (a pure phthalate) at the economy level.

Polycon #40 was developed for use in vinyl flooring, welting, garden hose and other extruded vinyls where slight plasticizer coloration is acceptable. Polycon #40 is also used in coated fabrics, slush and dip moldings, wire and cable coverings.

BROWN-ALLEN Polycon #40's features make it ideal for extrusion compounds. Among these features are:

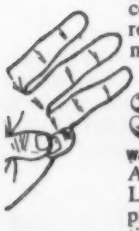
- Superior solvation
- Excellent toleration for low-cost plasticizer extenders
- Gelation and cure rates that help increase production in plastisols
- Greater toleration of filler loads

In addition, BROWN-ALLEN Polycon #40 offers a higher electrical resistivity than DOP by actual test on compounded products.



2 **For a low-cost replacement for n-Octyl n-Decyl Phthalates** where low temperature and low volatility are desirable, look into BROWN-ALLEN Polycon #5B.

Used in plastisols, BROWN-ALLEN Polycon #5B offers improved flow-out properties, slow gelation and fast cure in addition to low viscosity and excellent viscosity stability. This results in superior definition in complex molds.



3 **Whether you buy plasticizers in drums, tank wagons or tank cars,** find out about BROWN-ALLEN DOP, DIOP, ODP, DBP and DDP. Like all BROWN-ALLEN products, these plasticizers are precisely uniform, competitively priced and of dependably high quality.

For free samples, technical assistance and price information, *write today*.

BROWN-ALLEN CHEMICALS, INC.
Box I, Staten Island 2, New York

B-A

heliogens:

a series of phthalocyanine blues and greens for coloring plastics —of exceptional brilliance, tinctorial strength, fastness to light and chemical stability.

Our technical service representatives are available to help you with your plastics coloring problems.

general dyestuff co.

gdc gaf

A SALES DIVISION OF
GENERAL ANILINE & FILM CORPORATION
435 HUDSON STREET, NEW YORK 14, N. Y.
SALES OFFICES: New York • Boston • Providence
Philadelphia • Charlotte, N.C. • Chattanooga • Chicago
Portland, Ore. • San Francisco • Los Angeles • IN
CANADA: Chemical Developments of Canada, Limited,
Montreal

From the World's Largest Production Unit

CH_2O FORMALDEHYDE, MERCK CH_2O

Unrestricted quantities delivered within 24 hours to points in Middle Atlantic and New England areas. Write, wire or phone your requirements for Formaldehyde 37% and 45% Low Methanol (Uninhibited), and Inhibited; Hexamine Technical, Powder or Granular.

© Merck & Co., Inc.

MERCK

MERCK & CO., INC.
CHEMICAL DIVISION
RAHWAY, NEW JERSEY

NOW! Use CHLOROWAX 70 for low-cost flame-retardant polyesters

DIAMOND's Chlorowax® 70 is a powdered resin containing 70% chlorine. Use it together with antimony trioxide in pigmented polyester resin formulations and you can produce low-cost flame-retardant polyesters that will still retain *physical properties comparable to straight resin.*

EXAMPLE

	(Parts by Weight) Control	Flame Retardant
Polyester Resin	100.00	100.0
Chlorowax 70	—	12.5
Antimony Trioxide	—	12.5
Luperco ATC	2.0	2.0
Colored Pigment	as required	
3-oz Glass Mat	60.0	60.0
Flexural Strength psi, Dry 1	26,000	27,500
Flexural Strength psi, Wet 2	24,000	25,000
Tensile Strength psi, Dry 3	15,000	15,700
Tensile Strength psi, Wet	14,000	14,300
Flame-Out Time, Seconds 4	Burns	1

METHODS OF TESTING

1. Flexural Strength — ASTM-D650-42T
2. Water Immersion — 7 days immersion at room temperature
3. Tensile Strength — ASTM-D638-46T
4. Flammability Test — ASTM-D635-44 — Test specimen 1″ x 6″ x 3/32″ is suspended horizontally at 45 degree angle so that 1″ of the specimen is exposed in a 5″ (1-1/2″ blue core) flame from a Bunsen burner. The sample is exposed 30 seconds and then the flame is removed. To be classed flame resistant the sample must be self extinguishing in less than 20 seconds.

For more information about moneysaving Chlorowax 70, send for NEW Technical Bulletin on "Low-Cost Flame-Retardant Pigmented Polyester Compounds". DIAMOND ALKALI COMPANY, 300 Union Commerce Building, Cleveland 14, Ohio.

Diamond Chemicals



Thinking

about

COLOR?

HOMMEL
QUALITY

PIGMENTS
GIVE PLASTIC PRODUCTS NEW
LIFE, BRILLIANCE AND APPEAL

UNIFORM

STABLE

BRILLIANT

PIGMENT DIVISION

THE O HOMMEL CO
PITTSBURGH 30, PA.

WEST COAST
4747 E. 49th St., Los Angeles

How to figure your sales potential in the plastics field

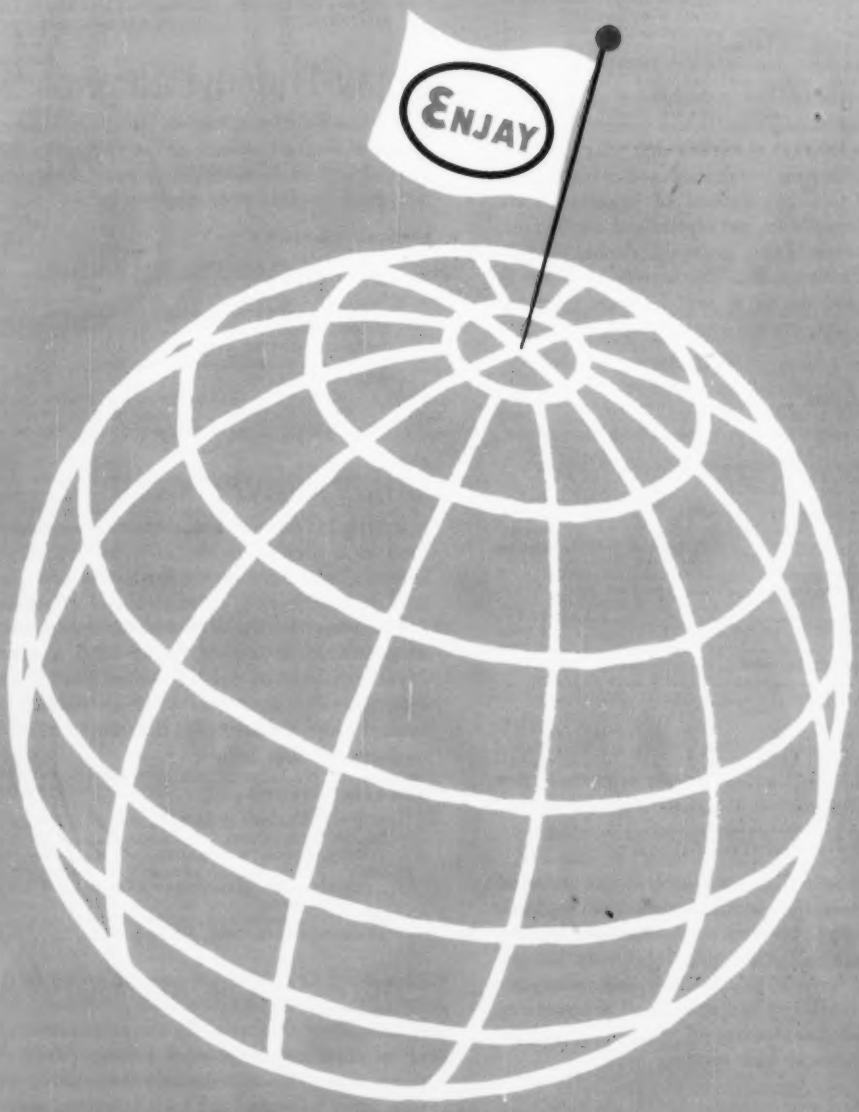


FREE . . . 40-page brochure will help you find answers to your questions about sales opportunities in the fast-growing plastics field.

THIS NEW STUDY contains the inside story of one of America's fastest growing industrial markets. It presents one of the most stimulating and detailed analyses of the plastics field that has yet been published. It's filled with up-to-date figures on the consumption and production of plastics materials, on the field's processing equipment requirements, on potential areas of growth. It lists hundreds of kinds of machines, accessories, chemicals and intermediates, supplies and special services for which the field is manifesting an ever-increasing appetite.

You will find this handsome brochure—file size, lavishly illustrated, 40-pages—a valuable addition to your business library. It may well point the way to increased sales for the industrial products or services that your firm supplies.

For your free copy of "The Plastics Field," simply address a note on your company letterhead to *Advertising Manager*, Modern Plastics, 575 Madison Avenue, New York 22.



PIONEER IN PETROCHEMICALS

Products · Service

ENJAY COMPANY, INC.
15 West 51st Street, New York 19, N.Y.
Other offices: Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

ALCOHOLS

Enjay Isopropyl Alcohol

is a valuable raw material for the manufacture of chemical derivatives such as acetone and esters. It is a solvent for many oils, resins and surface coating materials and may be used readily in extraction processes, cosmetics and varnish and lacquer formulations. Other applications of importance are anti-freeze, cleaning compositions, antiseptics and astringents, insecticides and disinfectants. Enjay isopropyl alcohol is available in 91% and anhydrous grades. The anhydrous grade is unique in its dryness and purity as will be seen from the following specifications and typical inspections.

SPECIFICATIONS

WATER, weight per cent, max.	0.15
SPECIFIC GRAVITY, 20/20°C, max.	0.7867
ACIDITY, as acetic acid, weight per cent, max.	0.002
COLOR, Hazen, max.	10
NON-VOLATILE MATTER, mg/100 ml, max.	2
DISTILLATION, °C	
Initial, min.	81.5
Dry point, max.	83.0
RESIDUAL ODOR	none
WATER DILUTION	Clear at infinite dilution

TYPICAL INSPECTIONS

Purity, volume per cent	99.9+
Specific gravity, 20/20°C	0.7866
60/60°F	0.7823
Acidity, as acetic acid, weight per cent	0.001
Color, Hazen	5
Non-volatile matter, mg/100 ml	1
Distillation, °C	
Initial	81.8
Dry point	82.4
Residual odor	none
Water dilution	Clear at infinite dilution

Enjay Isooctyl Alcohol

is a versatile raw material for the manufacture of chemical derivatives such as esters, isooctyl aldehyde and isooctoic acid. Di-isooctyl phthalate is a widely used plasticizer for synthetic resins such as vinyls. Other uses for Enjay isooctyl alcohol are as a solvent for oils, gums, waxes and resins, and as a coupling agent in emulsions and soluble oil concentrates, and as a solvent in the manufacture of greases, insecticide concentrates, textile lubricants and printing inks.

SPECIFICATIONS

PURITY, weight per cent, min.	99.0
SPECIFIC GRAVITY, 20/20°C, min.	0.830
max.	0.834
ACIDITY, as acetic acid, weight per cent, max.	0.001
COLOR, Hazen, max.	10
WATER, weight per cent, max.	0.10
CARBONYL NUMBER, mg KOH/g, max.	0.3
DISTILLATION, °C	
Initial, min.	184
Dry point, max.	191

Enjay Decyl Alcohol

is widely used in the manufacture of ester plasticizers such as didecyl phthalate and didecyl adipate as well as for co-esters such as isooctyl-decyl phthalate. Other uses for Enjay decyl alcohol are in the manufacture of anti-foaming agents, textile lubricants and herbicides.

SPECIFICATIONS

PURITY, weight per cent, min.	99.0
SPECIFIC GRAVITY, 20/20°C, min.	0.835
max.	0.840
ACIDITY, as acetic acid, weight per cent, max.	0.001
COLOR, Hazen, max.	10
WATER, weight per cent, max.	0.10
CARBONYL NUMBER, mg KOH/g, max.	0.3
DISTILLATION, °C	
Initial, min.	215
Dry point, max.	225
APPEARANCE	Bright and clear, free from suspended matter

Enjay Tridecyl Alcohol

is a valuable raw material for the manufacture of various chemical derivatives such as the mercaptan, sulfate and borate. It is also used in synthetic detergent manufacture as a condensation product with ethylene oxide.

SPECIFICATIONS

PURITY, weight per cent, min.	98.0
SPECIFIC GRAVITY, 20/20°C, min.	0.843
max.	0.848
ACIDITY, as acetic acid, weight per cent, max.	0.003
COLOR, Hazen, max.	25
WATER, weight per cent, max.	0.15
CARBONYL NUMBER, mg KOH/g, max.	0.7
DISTILLATION, °C	
Initial, min.	245
Dry point, max.	270
APPEARANCE	Bright and clear, free from suspended matter

Enjay Ethyl Alcohol

is a valuable solvent and chemical raw material. It is widely used as a solvent in the manufacture of shellac varnishes, lacquers, pharmaceuticals, cosmetics and plastics. It is also used in purification, extraction and crystallization processes. It has many important uses in the synthesis of a wide variety of chemical compounds. Enjay ethyl alcohol is available as Jaysol (proprietary solvent) as well as in specially denatured formulas. The properties of these alcohols are available on request. The specifications for Enjay ethyl alcohol used in their preparation follow.

SPECIFICATIONS

SPECIFIC GRAVITY @ 60/60°F, max.	0.8160
COLOR, Hazen, max.	10
PURITY, volume per cent, min.	95
DISTILLATION, °C	
Initial, min.	77.5
Final, max.	79
ACIDITY, as acetic acid, weight per cent,	0.002
PERMANGANATE TIME, minutes, min.	30

Enjay Secondary Butyl Alcohol

is a useful raw material for the preparation of chemical derivatives such as methyl ethyl ketone, esters, chloride and xanthate. Due to its intermediate evaporation rate, compatibility with other solvents, and high solvency, secondary butyl alcohol has wide application in the formulation of varnishes and lacquers.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.807
max.	0.809
ACIDITY, as acetic acid, weight per cent, max.	.002
COLOR	water white
DISTILLATION, °C	
Initial, min.	98.5
Dry point, max.	100.5
NON-VOLATILE MATTER, mg/100 ml., max.	2.0
PURITY, weight per cent, min.	99
RESIDUAL ODOR	none
WATER, weight per cent, max.	0.5

OLEFINS

Enjay Isobutylene

is a versatile, high purity chemical usable in a variety of syntheses. In addition to the normal olefin reactions, it may

be di[illegible]ized to isooctylenes or used in the alkylation of tertiary [illegible]raffins, aromatics, or phenols. Hydration yields tertiary [illegible]tyl alcohol. Reaction with oxides of nitrogen or nitrosyl [illegible]loride produces compounds of possible interest for the s[illegible]thesis of nitrogen derivatives.

SPECIFICATIONS

PURITY, weight per cent, min.	99.0
BUTENES, weight per cent, max.	0.8
BUTANES, weight per cent, max.	0.5
CARBONYL, as acetone, weight per cent, max.	0.01
SULFUR, ppm, max.	10
WATER, weight per cent, max.	0.007
DISTILLATION, °C, weight per cent below −15°, max.	0.05

Enjay Tripropylene

is an excellent source of 9-carbon olefins useful in ordinary olefin reactions as well as in alkylation of aromatics and phenols for the manufacture of detergents and resin intermediates.

SPECIFICATIONS

UNSATURATES, volume per cent, min.	97.0
SPECIFIC GRAVITY, 20/20°C, min.	0.733
max.	0.743
DISTILLATION, °F	
5% point, min.	250
95% point, max.	305
SULFUR, ppm, max.	20
PEROXIDES, active oxygen, ppm, max.	25
INHIBITOR, tertiary butyl catechol, ppm, min.	100

Enjay Tetrapropylene

is a primary source of 12-carbon tertiary olefins and responds to the general olefin reactions. It is a valuable raw material for the production of detergent intermediates such as dodecyl benzene. With hydrogen sulfide, it yields a mercaptan usable in the manufacture of synthetic rubber.

SPECIFICATIONS

UNSATURATES, volume per cent, min.	98.0
SPECIFIC GRAVITY, 20/20°C, min.	0.770
max.	0.785
DISTILLATION, °F	
Initial, min.	350
Dry point, max.	430
PEROXIDES, active oxygen, ppm, max.	20
INHIBITOR, U.O.P. No. 5-lbs/1000 bbls, min.	4

Nonene (Close Cut)

is a source of high-purity nonenes applicable in the manufacture of detergent and resin intermediates through alkylation and yielding products with closely controlled physical and chemical properties. Nonene is a potential source for a great variety of higher olefin derivatives.

SPECIFICATIONS

UNSATURATES, volume per cent, min.	99.0
SPECIFIC GRAVITY, 20/20°C, min.	0.736
max.	0.740
DISTILLATION, °F	
Initial, min.	260
Dry point, max.	290
SULFUR, ppm, max.	10
PEROXIDES, active oxygen, ppm, max.	25
INHIBITOR, tertiary butyl catechol, ppm, min.	100
APPEARANCE,	Bright and clear, free from suspended matter

DIOLEFINS

Enjay Butadiene

is a highly reactive, high purity diolefin which takes part in many reactions. It may be polymerized by itself or copolymerized with products such as styrene or acrylonitrile to yield resins and plastics. The styrene copolymer is the base of many water emulsion paints and of synthetic rubber. Butadiene reacts with maleic anhydride and its esters to yield cyclohexene dicarboxylic acids and their derivatives.

SPECIFICATIONS

CONJUGATED DIENE, as 1,3 butadiene, weight per cent, min.	98.0
ACETYLENES, as vinyl acetylenes, ppm, max.	500
CARBONYL, as acetaldehyde, ppm, max.	100
PEROXIDES, as hydrogen peroxide, ppm, max.	10
SULFUR, as hydrogen sulfide, ppm, max.	10
BUTADIENE DIMER, weight per cent, max.	0.2
HYDROCARBONS, (C_5), weight per cent, max.	0.1
NON-VOLATILE MATTER, weight per cent max.	0.1
OXYGEN IN VAPOR OF FILLED CAR, volume per cent, max.	0.3
INHIBITOR, tertiary butyl catechol, ppm, in tank car as loaded by consignor	100
APPEARANCE,	Clear and free of entrained matter

Enjay Isoprene

is a highly reactive diolefin similar in properties and reactions to butadiene and yielding generally the same types of derivatives. It is assuming an increasing importance as raw material for the manufacture of "synthetic natural rubber."

SPECIFICATIONS

ISOPRENE, weight per cent, min.	92.0
TOTAL DIOLEFINS, weight per cent, min.	95.0
CYCLOPENTADIENE, weight per cent, max.	1.0
ALPHA ACETYLENES, as isopropyl acetylene, weight per cent, max.	0.70
CARBONYL, as acetone, ppm, max.	100
SULFUR, ppm, max.	100
PEROXIDES, as hydrogen peroxide, ppm, max.	10
NON-VOLATILE MATTER, weight per cent, 60°C, max.	0.2
INHIBITOR, as loaded, ppm, min.	50
APPEARANCE,	Clear and free of entrained material

Enjay Dicyclopentadiene

is the source for the unique and highly reactive cyclopentadiene which is generated by heating dicyclopentadiene. Cyclopentadiene undergoes most of the reactions of normal diolefins and in addition may be converted to organo-metallic derivatives and mono- and di-carboxylic acids. With maleic anhydride, cyclopentadiene yields a dibasic acid. Cyclopentadiene monocarboxylic acid on reaction with maleic anhydride gives a tribasic acid. Dicyclopentadiene is a fruitful source for new chemicals.

SPECIFICATIONS

DICYCLOPENTADIENE, weight per cent, min.	95.0
DI(METHYL CYCLOPENTADIENE), weight per cent, max.	3.5
ACYCLIC DIENES, weight per cent, max.	2.5
HIGHER CYCLIC DIENES, weight per cent, max.	0.3
SPECIFIC GRAVITY, 20/20°C, min.	0.970
max.	0.985
COLOR, Gardner, max.	1.0
INHIBITOR, ppm, max.	250
APPEARANCE,	Clear and free of entrained matter

KETONES

Enjay Acetone

is a valuable solvent and chemical raw material in industry. It is used as a solvent for acetylene and for cellulose acetate for the manufacture of a wide variety of surface coating compositions and in industrial extraction processes. Acetone is a raw material for chemical derivatives such as chloroform, iodoform, isophorone, ketone and acrylic resins.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.791
max.	0.793
ACIDITY, as acetic acid, weight per cent, max.	0.002
COLOR, APHA, max.	5
WATER DILUTION, with distilled water	Clear
DISTILLATION, °C	
Initial, min.	55.5
Dry point, max.	56.5
NON-VOLATILE MATTER, mg/100 ml., max.	1.0
PURITY, weight per cent, min.	99.5
PERMANGANATE TEST, hours, min.	2.0
WATER	Clear with 19 volumes naphtha

Enjay Methyl Ethyl Ketone

is an efficient solvent for vinyl and other synthetic resins, nitrocellulose, cellulose acetate and buna-N type rubbers. Because of its solvent properties, it is employed in the manufacture of nitrocellulose cements, artificial leathers and fabric coating and photographic film. Methyl ethyl ketone in combination with benzol or toluene is used to reduce the wax content of lubricating oils. It is only partially miscible with water. The evaporation rate of methyl ethyl ketone is lower than that of acetone and is comparable to that of ethyl acetate.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.805
max.	0.807
COLOR, Hazen, max.	10
ACIDITY, as acetic acid, weight per cent, max.	0.002
DISTILLATION RANGE °C, including 79.6	1.5
NON-VOLATILE MATTER, mg/100 ml., max.	2.0
PURITY, weight per cent, min.	99.0
RESIDUAL ODOR	none
WATER, weight per cent	0.2

ACETATES

Enjay Isopropyl Acetate

is a low-cost lacquer solvent which has properties similar to ethyl acetate. It evaporates more slowly than ethyl acetate and, therefore, is valuable for blush-resistant formulations. Isopropyl acetate has good solvent properties which suggest a wide use in chemical industries.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.868
max.	0.872
COLOR, APHA, max.	5
ACIDITY, as acetic acid, weight per cent, max.	.01
DISTILLATION, °C	
Initial, min.	85.0
Dry point, max.	90.0
NON-VOLATILE MATTER, mg/100 ml., max.	2.0
PURITY, weight per cent, min.	95.0
RESIDUAL ODOR	none
WATER	Clear with 19 volumes naphtha

Enjay Secondary Butyl Acetate

is a medium boiling solvent used in the manufacture of nitrocellulose coatings, films and plastic products from many resins. It may replace blends of ethyl and normal butyl acetates and is particularly useful in the formulation of lacquer "sealers." Secondary butyl acetate dissolves manila, mastic, pontianak, ester, and other gums and asphalt and is miscible with vegetable oils. It is a partial solvent for shellac and does not dissolve cellulose acetate.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.861
max.	0.865
COLOR	water white
ACIDITY, as acetic acid, weight per cent, max.	.02
DISTILLATION, °C	
Initial, min.	104
Dry point, max.	115
NON-VOLATILE MATTER, mg/100 ml., max.	2.0
PURITY, weight per cent, min.	87
max.	90
RESIDUAL ODOR	none
WATER	Clear with 19 volumes naphtha

ETHERS

Enjay Ethyl Ether

is a standard solvent for fats, oils, waxes, gums, resins and nitrocellulose. It is useful in making rayon and pyroxylin compositions and as a solvent for extraction processes.

SPECIFICATIONS

SPECIFIC GRAVITY, 20/20°C, min.	0.712
max.	0.720
ACIDITY, as acetic acid, weight per cent, max.	0.005
ALCOHOL, weight per cent, max.	1.0
NON-VOLATILE MATTER, mg/100 ml., max.	0.002
WATER, weight per cent, max.	0.25
INHIBITOR, alpha naphthol, added, ppm.	85
COLOR, Hazen, max.	10

OTHER ENJAY PRODUCTS: Enjay also offers benzene, p-xylene, CTLA polymer, naphthenic acids, aromatic tars and distillates and wood-preserving solvents. For further information on these or other Enjay products—and for samples, supplies or technical assistance—call or write any Enjay office.



NEW ENJAY LABORATORIES OFFER TECHNICAL HELP IN THE APPLICATION OF ANY ENJAY PRODUCT

The new Enjay Laboratories, with the industry's most modern, most complete testing and research facilities, stand ready to give you any technical assistance you might need in the application of any Enjay petrochemical.

ENJAY COMPANY, INC.

ENJAY

15 West 51st Street, New York 19, N.Y.

Other offices: Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

There's one way to be SURE!

Make your products with

COLUMBIAN

Pigments, Colloidal Dispersions and Plasticizers

COLUMBIAN CARBON BLACKS

Carbon Blacks are indispensable elements of color in many plastics. Especially useful in plastics are: Neo Spectra® Mark II and III, Superba®, No. 999 and Raven® 15. The degree of jetness obtained depends on the particle size of the carbon and its degree of dispersion. In polyethylene pipe and cable sheathing carbon black protects from sun damage. Whatever your need, Columbian has a carbon black to fit it.

COLUMBIAN COLLOIDAL DISPERSIONS

Complete dispersion is a prerequisite of depth of color. Many manufacturers have found profitable satisfaction in using Columbian Colloidal Dispersions of carbon blacks. These complete dispersions in any vehicle give greatest jetness and THEY ARE CLEAN to handle and use. They produce jet black plastics with ease; and predispersed color needs only mixing, no grinding.

COLUMBIAN MAPICO® IRON OXIDES

A wide range of beautiful and notably uniform yellows, tans, reds, browns and black, these pure synthetic iron oxide pigments possess excellent alkali and acid stability, extreme light-fastness, and valuable ultra-violet screening characteristics. Useful in vinyls, polyethylene, polystyrene, polyesters; for flooring, sheeting, coated textiles, toys, dolls, mats, footwear, insulation compounds and others.

PLASTICIZERS

Latest in plasticizing dependability, the new POLYMERIC type is outstanding for easy processing and permanence. Use Harflex 300 or 325. The results will surprise you. Other Plasticizers — PHTHALATES, SEBACATES, ADIPATES — include the low-temperature, low-volatile, low-water-soluble DIOCTYL SEBACATE and DICAPRYL PHTHALATE.

Our Technical Service Department is always ready to assist you.



COLUMBIAN CARBON COMPANY

380 Madison Avenue, New York 17, N.Y.

BASIC REASONS FOR

CELANESE

PLASTICIZERS

CELLUFLEX 179-A (Tricresyl Phosphate, low ortho content) — contains lowest ortho content commercially available. Useful as a flame-resistant plasticizer, particularly in cellulosics and vinyls.

CELLUFLEX 179-EG (Tricresyl Phosphate, electrical grade)—affords the insulation industry excellent solvent properties and inherent flame resistance with uniform high electrical characteristics and lower weight per unit volume.

CELLUFLEX 179C (Tricresyl Phosphate, general purpose grade)—combines excellent solvent power and flame retardant properties as general plasticizer for vinyl resins and cellulosic plastics. Especially advantageous for coatings and films where extreme flame resistance and toughness are vital.

LINDOL (Tricresyl Phosphate, low color)—a standard flame-resistant plasticizer in vinyl and cellulosic plastics.

CELLUFLEX 112 (Cresyl Diphenyl Phosphate)—useful in achieving a high degree of flame resistance in vinyl formulations with better low temperature properties than can be reached with tricresyl phosphate.

CELLUFLEX TPP (Triphenyl Phosphate)—most widely used plasticizer in cellulose acetate. Provides excellent fire resistant properties, good flexibility; produces clear tough compositions.

CELLUFLEX DBP (Dibutyl Phthalate)—excellent light and heat stability, low viscosity plasticizer. Most widely used plasticizer for cellulose nitrate lacquers and coatings. Produces good gloss, high flexibility.

CELLUFLEX DOP (Dioctyl Phthalate)—low volatility, excellent heat and light stability, superior electrical properties. Primary plasticizer for vinyl resins, synthetic rubber in cloth coatings, elastomeric molded materials.

CELLUFLEX CEF (Trichloroethyl Phosphate)—flame-retardant with excellent plasticizing properties. Widely used with polyurethane, phenolics, cellulosics and polyvinyl acetate. Secondary plasticizer for polyvinyl chloride.

LINDOL® CELLUFLEX®

DESCRIPTIVE DATA

CELANESE PLASTICIZER	APPEARANCE	COLOR APHA Max	SPECIFIC GRAVITY @20/20°C	ACIDITY mg KOH/gram sample, Max	PERMANGANATE TIME, Min (in minutes)	WATER CONTENT % Max by Wt
CELLUFLEX 179-A tricresyl phosphate; low ortho content	Clear transparent liquid	100	1.143±.006	0.1	30	0.1
CELLUFLEX 179-EG* tricresyl phosphate; electrical grade	Clear transparent liquid	100	1.143±.008	0.1	30	0.1
CELLUFLEX 179C tricresyl phosphate; general purpose grade	Clear transparent liquid	100	1.165±.005	0.1	30	0.1
LINDOL tricresyl phosphate; low color	Clear transparent liquid	50	1.167±.005	0.1	30	0.1
CELLUFLEX 112 cresyl diphenyl phosphate	Clear transparent liquid	40	1.205±.005	0.1	30	0.1
CELLUFLEX TPP triphenyl phosphate	White Flakes	20 (molten)		0.03	30	0.1
CELLUFLEX DBP dibutyl phthalate	Clear transparent liquid	25	1.045±.003	0.1	—	0.1
CELLUFLEX DOP dioctyl phthalate	Clear transparent liquid	25	0.985±.004	0.1	—	0.1
CELLUFLEX CEF trichloroethyl phosphate	Clear transparent liquid	50	1.425±.005	0.1	—	0.1

*Cell Resistivity: 10 megohm/cm x 10^9 @ 23°C, min

TECHNICAL SERVICE

If you are limited by space and time, experienced chemists in the fully-equipped CELANESE TECHNICAL SERVICE AND APPLICATION LABORATORIES will be glad to assist you in the development of new and improved formulations. Trial lots will be subjected to specified tests and production costs analyses prepared.

IMPROVED PRODUCTS

CELANESE

INTERMEDIATES

ACETIC ACID (Glacial)—reactant and solvent in manufacture of cellulose acetate.

ACETIC ANHYDRIDE — acetylating agent used primarily for the esterification of cellulose to cellulose acetate.

BUTYRIC ACID—used in manufacture of cellulose acetate-butyrates for molded products, lacquers, weatherproof coatings.

FORMALDEHYDE (Formalin) — reacts with phenol, urea and melamine to form plastics and resinous products.

FORMCEL SOLUTIONS — relatively water-free formaldehyde solutions in selected alcohols. Starting materials for production of alcoholated condensation resins.

METHYL ISOPROPENYL KETONE—new vinyl monomer which forms tough plastics in homopolymerization and copolymerizes with many commercially available vinyls for use as plastics, films, elastomers and adhesives.

PARAFORMALDEHYDE—low water content formaldehyde (91% assay as formaldehyde) in solid form, used in production of urea and phenolic resins for greater efficiency in cycle time, yield and production costs.

P. E. (Pentaerythritol)—used in manufacture of medium and long oil alkyd resins, to produce surface coatings with higher gloss retention, faster drying time, increased durability. Also used in production of rosin esters and synthetic drying oils.

PROPIONIC ACID—used for production of cellulose propionate, a molding powder exhibiting superior impact strength and aging characteristics.

VINYL ACETATE MONOMER — basic material in manufacture of polyvinyl resin adhesives, textile and paper coatings, plastic films, sheeting and molding materials, water-emulsion paints.

FORMCEL®

SOLVENTS

	DESCRIPTIVE DATA				APPLICATION DATA (A—Active; L—Latent; N—Non-Solvent)				
	POUNDS/ GALLON @20°C	DISTILLATION RANGE °C	EVAP. RATE (Butyl Acetate—1)	FLASH POINT OPEN CUP °F	CELLULOSE NITRATE (RS Type)	ETHYL CELLULOSE (46.8-48.5 Ethoxyl)	CELLULOSE ACETATE (56% Acetic Acid)	VINYL ACETATE CHLORIDE (87% Vinyl Acetate)	CHLORINATED RUBBER
KETONES									
Acetone	6.61	1.0, inc. 56.1	7.7	15	A	A	A	A	L
Methyl Ethyl Ketone	6.72	1.5, inc. 79.6	5.3	22	A	A	A	A	A
ESTERS									
Propyl Acetate	7.32	95-103	2.7	65	A	A	N	N	A
Butyl Acetate	7.29	118-128	1.0	100	A	A	N	N	A
Ethylene Glycol Diacetate	9.21	186-195	0.02	205	A	A	A	N	N
ALCOHOLS									
Methanol	6.60	1.0, inc. 64.6	3.5	65	A	A	L	N	N
Propanol	6.70	2.0, inc. 97.15	1.1	90	L	A	N	N	N
Isobutanol	6.70	2.0, inc. 107.9	0.7	103	L	A	N	N	N
Butanol	6.75	1.5, inc. 117.7	0.4	115	L	A	N	N	N
GLYCOLS									
Propylene Glycol	8.64	185-190	—	225	A	N	N	N	N
1,3-Butylene Glycol	8.40	200-215	—	250	A	N	N	N	N
2,3-Butylene Glycol	8.41	175-195	—	185	A	N	N	N	N
SPECIAL SOLVENTS*									
Celanese Solvent 203	6.78	115-120	0.43	100	L	A	N	N	N
Celanese Solvent 301	6.72	98-101	1.1	90	L	A	N	N	N
Celanese Solvent 601	7.07	74-84	4.7	10	A	A	A	A	A
Celanese Solvent 901H	7.0	125-155	0.25	120	L	A	N	N	N
GLYCOL-ETHERS									
3-Methoxy Butanol	7.68	155-164	0.12	163	A	A	A	N	N

*A group of economical replacements for Butyl Alcohol & Methyl Ethyl Ketone.

For complete information, samples, prices, write:

CELANESE CORPORATION OF AMERICA
CHEMICAL DIVISION
180 Madison Avenue, New York 16, N. Y.

Celanese® CHEMICALS



In these five Standard Units are all the necessary components to control effectively the degradation mechanisms that take place in polyvinyl chloride resins on aging, during heat processing or on exposure to sunlight. They are widely used alone and in combinations for specific effects in clear and opaque stocks. Their advantages have been proven over other tested materials, such as those based on tin (which frequently decolorizes effects of degradation without correcting them) or on lead (which frequently contributes to oxidation and breakdown on aging). To correct special conditions encountered in each Vinyl Processing Industry, we also supply combinations of selected components in these five Standard Units.

Write for information about stabilizers designed for versatile and inexpensive use in formulations employed in your particular vinyl processing industry.

Is it for—

Quality Vinyl Flooring?
Non-Plating Calendered Stocks?
Maximum Clear Sheets?
Non-Sulfur Staining Films?
Low Cost Clear & Opaque Hose?
Top Physical Properties in Rigids?
Air-Releasing Plastisols?
Controlled Slush Molding?

This Stabilizer System is for

Vinyl Flooring

Ba-Cd 12-V-1
Ba-Zn 19-V-2

The HARSHAW CHEMICAL Co.

1945 E. 97th STREET • CLEVELAND 6, OHIO

HARSHAW PIGMENTS

INORGANIC PIGMENTS

Harshaw Pigments find widespread application in industry, especially where an inorganic type of pigment is desirable, such as in automobile and sign enamels and lacquers, permanent inks, resin and latex emulsion paints, plastics, artificial leather, fire-retardant coatings, rubber goods, wallpaper and artists colors. Wherever they are used, Harshaw colors show outstanding brilliance, strength and light fastness.

Yellows... Cadmium Lithopones and C. P. Cadmium Pigments—Primrose, Lemon and Golden
Sun Yellow N and C—extremely durable pastel yellow pigments (Nickel titanium dioxide complex.)

Oranges.. Cadmium Lithopones and C. P. Cadmium Pigments—Orange and Orange Red

Reds..... Cadmium Lithopones and C. P. Cadmium Pigments—Light Red, Medium Red, and Dark Red

Maroons.. Cadmium Lithopones and C. P. Cadmium Pigments—Maroon and Dark Maroon

Blues..... Cobalt Blue and Cerulean Blue

White.... Antimony Oxide

Other Colors and Pigments

Harshaw also offers a broad line of organic pigment colors, as well as a full line of Aurasperse organic and oxide dispersions. The dry colors are for general color uses, while Aurasperse dispersions find application in emulsion plant formulations.

A partial listing

ORGANIC PIGMENTS
Dry Colors

Hansa Yellows
Benzidene Yellows
Pigment Scarlet
Fire Red Toner
Maroon Toner
Permanent Orange
Madder Lakes
Permanent Green
Blue and Violet Toners
Permanent Purples

DISPERSED PIGMENTS
Aurasperse Colors

Hansa Yellows
Yellow Oxides
Green Gold
Chlorpara Red
Toluidine Red
Naphthol Reds
Alizarine Reds
Chlornaphthol Reds
Phthalocyanine Blue
Ultramarine Blue
Pigment Green B
Phthalocyanine Green
Chromium Green Oxide
Carbon Black
Red Oxides



HARSHAW

THE HARSHAW CHEMICAL CO.
Cleveland 6, Ohio
Chicago 32, Ill • Cincinnati 13, Ohio • Detroit 28, Mich. • Houston 11, Texas
Los Angeles 22, Calif. • Philadelphia 48, Penna. • Pittsburgh 22, Penna.
Hastings-On-Hudson 6, N. Y.

SEND FOR FREE LITERATURE

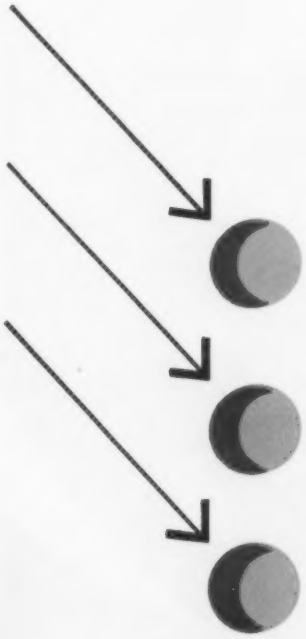
Harshaw Cadmium Lithopones
Harshaw Aurasperse Colors
Harshaw Pigment Scarlet 25 AD
Harshaw Benzidine Toner Yellow 2222

COMPOUNDS

IN THERMOPLASTICS

by Reed

GIVES YOU 3-WAY ASSURANCE OF PERFECT RESULTS



Special effects "unlimited" . . . opaque, transparent, translucent, opalescent, pearlescent, metallic, fluorescent, *any* effect you desire. We have built our reputation by solving difficult coloring problems of every type.

Service plus! Samples and production can be manufactured to your specifications and, in many cases, shipped to your plant overnight.

Quality without question! We have the largest staff of experienced chemists and the most modern thermoplastics laboratory in the industry.

Matching of colors is a REED specialty. We welcome an opportunity to match your samples!

Reed Plastics Corporation

116 GOLD STREET • WORCESTER, MASS.

RONA
TRADE MARK

PEARL ESSENCE
and
Pearlescent Pigments

• **SYNTHETIC PEARL PIGMENTS** to meet the most rigid specifications . . . heat stable, chemically resistant and non-corrosive.

• **NATURAL PEARL ESSENCE** derived from fish scale guanine of the highest quality, to provide maximum luster, brilliance and coverage.

A PRODUCT FOR EVERY TYPE OF PLASTIC

Constant research and development offer you the very best pearlescent pigments on the market.

Many completely new products have been developed over the past year.

Chemical laboratory control coupled with extensive production facilities assure you of uniform high quality at a remarkably low cost.

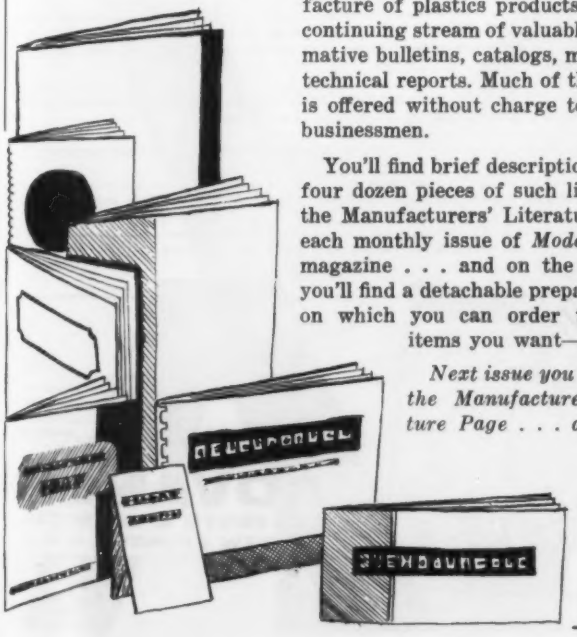
RONA LABORATORIES, INC.

East 21st and East 22nd Sts., Bayonne 19, N. J.

Manufacturers of Pearl Essence exclusively

Plants: Maine • New Jersey • Canada

Yours for the asking!



The companies that supply the equipment, resins, chemicals, molding compounds and services used in the manufacture of plastics products turn out a continuing stream of valuable and informative bulletins, catalogs, manuals, and technical reports. Much of this material is offered without charge to interested businessmen.

You'll find brief descriptions of about four dozen pieces of such literature on the Manufacturers' Literature Page of each monthly issue of *Modern Plastics* magazine . . . and on the same page you'll find a detachable prepaid postcard on which you can order the specific items you want—*free.*

Next issue you get, turn to the Manufacturers' Literature Page . . . and use it!

DON'T LET BLOCKING and STATIC *HOLD UP* POLYETHYLENE PRODUCTION

SLIP-EZE

will prevent static
prevent tackiness
prevent blocking

but

SLIP-EZE

will discolor plastic
make plastic greasy

not

SLIP-EZE

is a white, free-flowing, crystalline material. It will not form lumps and therefore can be easily mixed with your present formulation. Write today for information on how your production problems can be solved **with**

SLIP-EZE

Approved by the Food and Drug Administration

FINE ORGANICS, INC.
211 EAST 19th STREET
NEW YORK 3, N. Y.
GRAMERCY 5-1030

	DESCRIPTION	USE
BARIUM		
ADVASTAB B-13-P	Liquid Barium Organic Complex containing Auxiliary Stabilizers	In combination with Z-6 in processing of calendered products, extrusion and p[illegible]sols, where resistance to sulfide staining is a prime necessity. Also in vinyl asbestos til[illegible]
BARIUM-CADMIUM (Powder)		
ADVASTAB BC-12	Co-precipitated Barium-Cadmium-Laurate	General purpose heat and light stabilizer providing lubrication, exceptionally [illegible]ted when a powdered material is desired.
BARIUM-CADMIUM (Liquid)		
ADVASTAB BC-74	Barium-Cadmium Chelate Complex	A liquid system for all types of processing where lubrication is **not** desired. Gives maximum clarity obtainable from a Barium-Cadmium system. Excellent light stability.
ADVASTAB BC-105	Barium-Cadmium Chelate Complex	Plastisols, organosols and chemically blown sponge. Rigids (with C-79 and CH-201) where clarity and long term stability are imperative. In calendered stock to minimize plate-out.
BARIUM-ZINC		
ADVASTAB BZ-51	Barium-Zinc Chelate Complex	Completely eliminates sulfide staining under all processing conditions. Using BZ-51 in conjunction with BC-74, BC-105 or C-79 maintains stain resistance with maximum heat stability.
ADVASTAB BZ-155	Co-precipitated Barium-Zinc Soap	Specifically designed for calendering, extrusion and floor tile. Provides lubrication with complete resistance to sulfide staining.
CADMIUM		
ADVASTAB C-79	Liquid Cadmium containing Auxiliary Stabilizers	For garden hose, tubing, film and sheeting, where maximum resistance to water absorption is essential, and where clarity is important to the consumer market.
AUXILIARIES		
ADVASTAB CH-101	Non-metallic Organic Auxiliary Stabilizer	Extends the heat cycle for safe processing and aids in obtaining clarity. An auxiliary stabilizer for all primary metallic stabilizers including lead. Powerful anti-oxidant.
ADVASTAB CH-201	Non-metallic Organic Auxiliary Stabilizer	Extends the heat cycle for safe processing and aids in obtaining clarity. Preferred over CH-101 where no Epoxy Plasticizer is included.
ZINC		
ADVASTAB Z-6	Liquid Zinc containing Auxiliary Stabilizers	Used only in conjunction with Advastabs B-13-P, BC-12, BC-74 or BC-105 for maximum heat and light stability together with minimum sulfide staining.
EPOXY		
ADVASTAB E-82	Concentrated Epoxy-type Stabilizer	Extends performance of primary stabilizers, thus giving improved long-term heat stability. Particularly suited in systems containing zinc stabilizers or phosphate plasticizers.
ORGANO-TIN		
ADVASTAB T-52	Complex Organo-Tin Compound in Plasticizer Carrier	For clarity, brilliance and light resistance in calendered film and plastisols. For garden hose, tubing and film where water resistance is imperative.
ADVASTAB T-52-N	Complex Organo-Tin Compound in Plasticizer Carrier	A modification of our standard T-52, giving improved heat stability; and because of its cost advantage, is recommended for premium grade garden hose, tubing, clear film and sheets where water resistance is important.
ADVASTAB T-17-M	Organo-Tin Sulfur Compound	For plasticized stock, plastisols and rigids. Gives maximum heat stability necessary for prolonged cycles at high processing temperatures. Non-lubricating.
ADVASTAB T-671	Organo-Tin Sulfur Compound	For plasticized stock, plastisols and rigids. Outstanding clarity, improved odor characteristics, provides lubrication.
ADVASTAB T-50-LT	Concentrated Organo-Tin Compound	Most effective organo-tin stabilizer with lowest toxicity of any tin stabilizer known at present. Gives high clarity to plasticized and rigid vinyls.
ADVASTAB T-72	Concentrated Organo-Tin Compound	Similar to T-50-LT with improved lubricating property. For rigids and plastisols, may be used alone or with small amounts of Advastab C-79 and E-82.

ADVANCE *also makes . . .*

ADVAWET #212
Plastisol Viscosity Depressant

ADVAWAX #280
N,N'-Ethylenebis-Stearamide

ADVABRITE M-10
Fluorescing Agent and Whitener

PLASTOFLEX VS
Tetrahydrofurfuryl Oleate

PLASTOFLEX #3
Modified Adipate Plasticizer

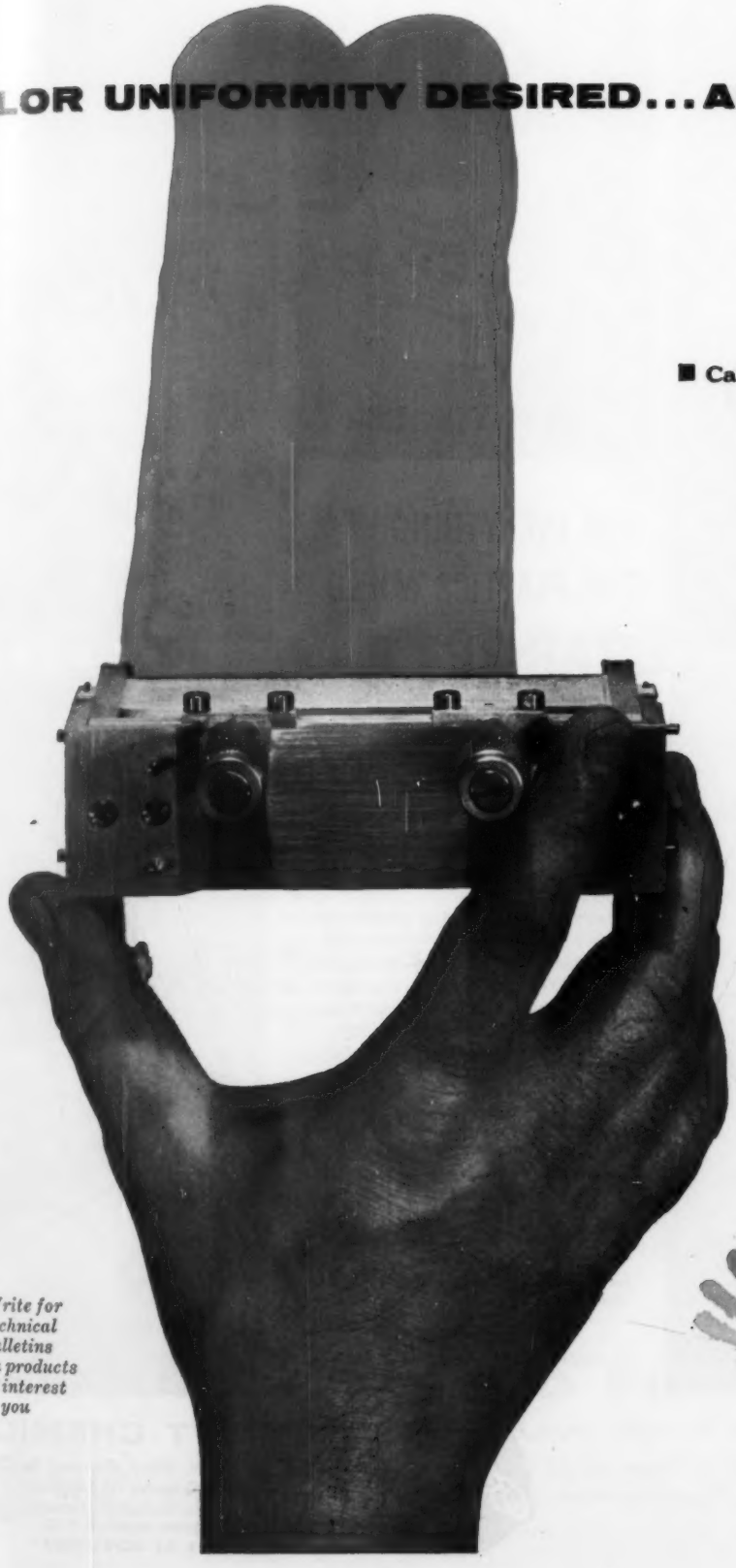
ADVANCE *Vinyl Stabilizers*

FACT FILE
Vinyl Stabilizers

A&W
DIVISION OF CARLISLE CHEMICAL WORKS, INC.

ADVANCE
SOLVENTS & CHEMICAL
NEW BRUNSWICK, N. J.

COLOR UNIFORMITY DESIRED...ABSOLUTE



CLAREMONT

the preferred source for a complete range of

■ **Calibrated Color Concentrates for coloring:**

Polyethylene

■ **Calibrated color pastes for coloring:**

Vinyl Plastisols

Vinyl Film & Sheeting

Epoxy Resins

Polyester Resins

■ **Gravure and Valley Inks for printing**

du Pont Mylar

Polyethylene

Vinyl

Ink formulations for Gravure and flexographic printing on all plastics. Full color range including metallics.

Write for technical bulletins on products of interest to you

CLAREMONT

pigment dispersion corp.
39 powerhouse road
roslyn heights, l. i.







FOR EVERYTHING IN
THE PLASTICS WORLD

BARRETT

PLASTICIZERS

***Dibutyl Phthalate**—one of the best known plasticizers for nitrocellulose.

***Dimethyl Phthalate**—For cellulose acetate film, sheeting and molding powders.

ELASTEX® DCHP Plasticizer—for heat-sealing cellophane. A processing aid for vinyls.

***"ELASTEX" 10-P Plasticizer (DIOP)**—Low volatility and excellent electrical properties.

***"ELASTEX" 18-P Plasticizer**—for retention of properties after heat aging.

***"ELASTEX" 20-A Plasticizer**—imparts low volatility in low temperature formulations.

***"ELASTEX" 28-P Plasticizer (DOP)**—Best general purpose vinyl plasticizer.

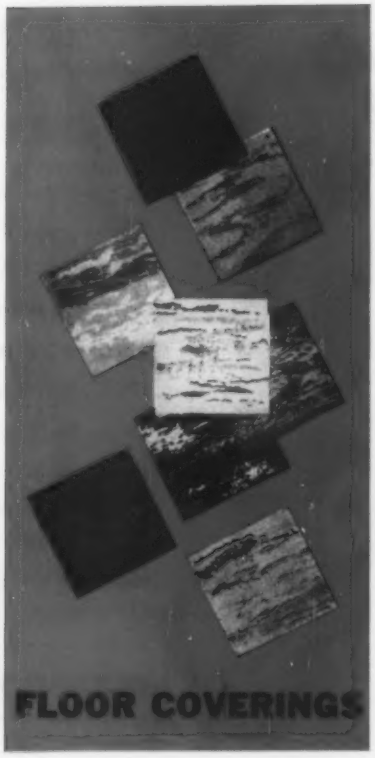
***"ELASTEX" 40-P Plasticizer**
***"ELASTEX" 48-P Plasticizer**
***"ELASTEX" 50-B® Plasticizer**
} for special economy
with general purpose plasticizers in vinyls.

***"ELASTEX" 60-A Plasticizer (Dioctyl Adipate)**—For low temperature applications.

***"ELASTEX" 90-P Plasticizer**—upgrades aging characteristics.

Ask your Barrett representative for complete information.

*Available in tank cars and tank trucks.





Barrett®

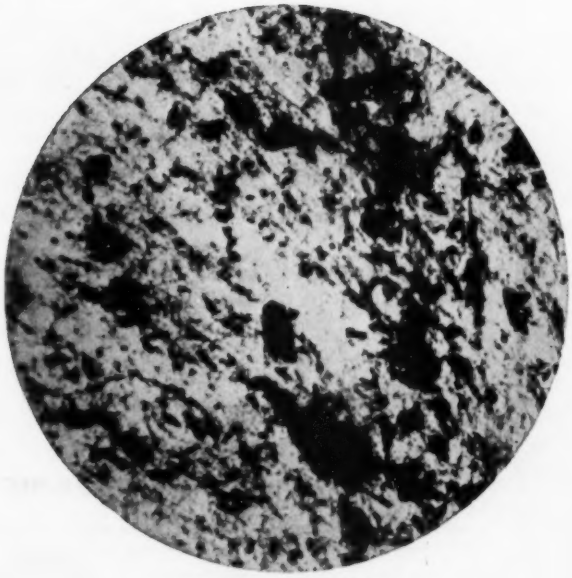
BARRETT CHEMICALS

BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N.Y. In Canada: The Barrett Company, Ltd., 5551 St. Hubert Street, Montreal, P. Q.

Allied Chemical

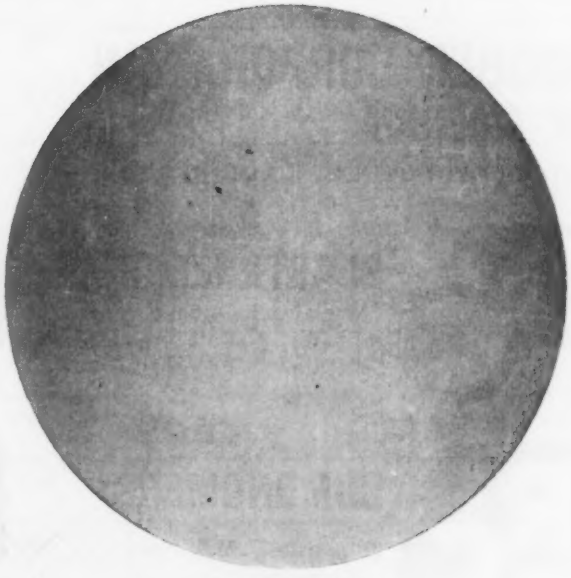
OVER 100 YEARS OF EXPERIENCE

Are your troubles caused by poor dispersions?



ORDINARY DISPERSION
MAGNIFICATION 140X

If you are making your own dispersions you may be discovering some problems . . . agglomeration, costly clean-up time, excessive compounding time and contamination. ADP Dispersions will eliminate agglomeration and contamination, reduce compounding time and clean-up time in your plant. Dispersion is a highly technical science, requiring specialized research and production techniques. ADP is unique in this respect, because of its background of close to a half-century of experience. ADP specialists, without obligation, will gladly consult with you. **Their business** is dispersions, and they know it thoroughly. They will be glad to help you.



ADP DISPERSION
MAGNIFICATION 140X

ACHESON DISPERSED PIGMENTS CO.

MORRIS BUILDING, PHILADELPHIA 2, PA.

West Coast Distributor: B. E. Dougherty Co., Los Angeles 21, Calif.

In Europe: Acheson Dispersed Pigments, Bridge St., Dunkinfield, Cheshire, England

A UNIT OF ACHESON INDUSTRIES, INC.

ORGANIC PEROXIDES

CATALYSTS FOR POLYMERIZATIONS • DRYING ACCELERATORS
OXIDATION AGENTS • BLEACHING AGENTS

LUCIDOL* (BENZOYL PEROXIDE)

LUPERCO* (PEROXIDE COMPOUNDS)

ALPEROX* C (TECHNICAL LAUROYL PEROXIDE)

LUPEROX* (PEROXIDE PASTES)

LUPERSOL* (PEROXIDE SOLUTIONS)

SPECIAL ORGANIC PEROXIDES

WAREHOUSE STOCKS CONVENIENTLY LOCATED THROUGHOUT THE COUNTRY

*REGISTERED  TRADE MARK

LUCIDOL DIVISION

WALLACE & TIERNAN INCORPORATED, BUFFALO 5, NEW YORK

RUBBER CORPORATION OF AMERICA

suppliers of outstanding:



PLASTICIZERS

Phthalates — Glycol Esters
Adipates — Fatty Acid Esters
Sebacates — Polyesters

PLASTISOLS

Dipping — Casting
Extruding — Slush Molding

COMONOMERS

Fumarates — Maleates

RIGID PLASTISOLS

Custom-made — All Colors

Consult our fully equipped laboratory for the answer to your problem.

Write today to:

RUBBER CORPORATION OF AMERICA New South Road, Hicksville 7, N. Y.

Sales Offices: NEW YORK • AKRON • CHICAGO • BOSTON



THE KEY TO HARCHEM® BETTER PLASTICS

HARFLEX® PLASTICIZERS

FOR VINYL RESINS, SYNTHETIC RUBBERS, CELLULOSE ESTERS

Outstanding for low temperature flexibility, low viscosity, low heat loss, and maintenance of flexibility over wide temperature ranges.

The Harchem Division offers you a wide choice of Plasticizers which keep your product young. Sebacate esters are particularly good on weathering and ageing.

Harchem has developed many plasticizers with special merits which enable you to select the product best suited to your needs.

Consult us if you have a plasticizer problem. Our technical staff will be glad to assist you in solving it.

Plasticizer	Boiling Point Degrees C.	Specific Gravity 20°/20°C	Viscosity Centistokes 100°F.	Major Use	Outstanding Characteristics
Dibenzyl Sebacate	265°C @ 4mm	1.055*	13.0	Vinyl Resins, Rubbers	Low Temp. Flexibility, Low Volatility
Dibutyl Sebacate	180°C @ 3mm	0.936	6.1	Vinyls, Rubbers, Cellulose Esters	Low Temp. Flexibility, Excellent Aging Qualities
Dicapryl Sebacate	230-240°C @ 4mm	0.907	13.0	Vinyl Resins	Low Temp. Flexibility, Low Volatility
Dihexyl Sebacate	184°C @ 1mm	0.911	9.2	Vinyl Resins, Rubbers	Low Temp. Flexibility, Low Cost
Diisooctyl Sebacate	248-255°C @ 4mm	0.917	15.5	Vinyl Resins	Low Temp. Flexibility, Low Volatility
Dimethyl Sebacate	294°C @ 760mm	0.986*	3.6	Cellulose Esters, Rubbers	High Solvency, Wide Compatibility
Dioctyl Sebacate	248°C @ 4mm	0.916	12.7	Vinyl Resins	Low Temp. Flexibility, Low Volatility
Dicapryl Phthalate	222-230°C @ 4mm	0.972	28.8	Vinyl Resins, Rubbers	Highly Compatible, Low Volatility
Dihexyl Phthalate	210°C @ 5 mm	0.995	28.8	Vinyl Resins	Highly Compatible, Good Flexibility
Diisodecyl Phthalate	250-257 @ 4 mm	0.966	43	Vinyl Resins	Low volatility
Dioctyl Phthalate	225-235°C @ 4mm	0.985	29.7	Vinyl Resins, Rubbers	Highly Compatible, Good Flexibility
Isooctyldecyl Phthalate	234-253°C @ 4mm	0.975	37	Vinyl Resins, Rubbers	Improved Flexibility, Permanence
Dicapryl Adipate	211-217°C @ 4mm	0.915	8.3	Vinyl Resins, Rubbers	Low Temp. Flexibility, Low Cost
Dioctyl Adipate	213°C @ 4mm	0.927	8.2	Vinyl Resins, Rubbers	Low Temp. Flexibility, Low Cost
®Harflex 300		1.098	1100	Vinyl Resins	Non-migratory, Low Temp. Flexibility
®Harflex 325		1.104	1960	Vinyl Resins	Non-migratory, Permanence
®Harflex 500	230-240°C @ 4mm	0.933	9.9	Vinyl Resins	High Heat Stability, Low Temp. Flexibility

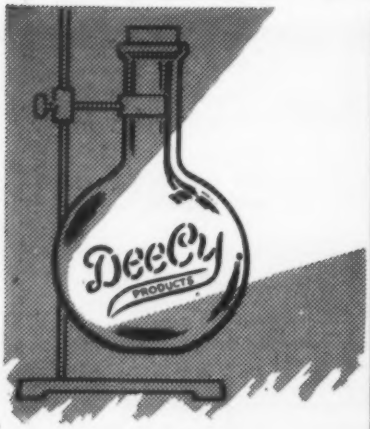
* 30°/20°C

MANUFACTURERS OF
CAPRYL ALCOHOL
SEBACIC ACID

THE KEY TO HARCHEM® BETTER PLASTICS

HARCHEM DIVISION

WALLACE & TIERNAN, INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
IN CANADA: W. C. HARDESTY CO. OF CANADA, LTD., TORONTO



Plasticizers & Stabilizers

STAFLEX® KA

Phthalates

Adipates

Azelates

Sebacates

Ricinoleates

Technical Bulletins and Samples sent on request.

DEECY PRODUCTS CO.
PLASTICIZERS STABILIZERS
120 Potter St. Cambridge 42, Mass.

Have You a Colorant Problem?

Poly-Supra can save you dollars in colorant costs per 100 pounds plastic without sacrifice of quality in most cases

Let's take the case of LOMA PLASTICS, INC. in Fort Worth, Texas, manufacturers of the well known LomaWare housewares line. After a telephone consultation with Mr. Louis H. Barnett, President of Loma, a trained plastics color expert flew into Fort Worth within two days, and worked in their plant for several days assisting them in setting up a dry colorant system that eliminated problems of dispersion, dusting, contamination, machine hopper feeding, etc. Research also uncovered that less dry colorants were necessary and the savings from this resulted in savings to Loma Plastics.



"THE MOLDER'S PET"

Please write us for free color chips or color matches, at no obligation, designating the exact specification of the material you would like to see in color. We will be happy to have a trained expert call on you too and work out your problems. If you wish further detailed information, call collect to Larry Krieger, Executive Vice President, HOllywood 4-7361.

We manufacture *the complete* line of dry colorants for in-plant coloring of all thermoplastic molding powders.

KRIEGER COLOR & CHEMICAL CO., INC.
6531 Santa Monica Blvd. Los Angeles 38, Calif.

INORGANIC PIGMENTS *for plastics*

PERMANENT • DEPENDABLE
RESIST FADING AND HIGH TEMPERATURES
INSOLUBLE IN SOLVENTS and PLASTICIZERS

Suitable for
CASTING · INJECTION or COMPRESSION MOLDING · CALENDERED FILMS AND COATING PROCESSES

LET US KNOW THE APPLICATION

Drakenfeld

B. F. DRAKENFELD & CO., INC.
45 Park Place • New York 7, N. Y.
***Factory and Laboratories:* Washington, Pa.**
Pacific Coast Agents:
Braun Corp., Los Angeles 54
Braun-Knecht-Heimann Co., San Francisco 19





9055 DGP...for low cost

there is a

PLASTOLEIN® PLASTICIZER

which fits your specific needs

If you need low temperature performance...
Plastolein 9058 DOZ (di-2-ethylhexyl azelate) and 9057 DIOZ (di-iso-octyl azelate), the most versatile *low-temperature* vinyl plasticizers available, are characterized by outstanding low-temperature flex; low volatility, high plasticizing efficiency, good heat and light stability and unusually low water and soapy water extraction.

If you need extreme permanence...
Plastolein 9720 imparts extreme *durability* and *weatherability* to plastic materials—providing unusually low volatility, high resistance to oil and water extraction, excellent stability to heat and light, resistance to migration.

If you need low-cost...
Plastolein 9055 DGP is a low cost, *low-temperature, secondary* plasticizer which provides high efficiency, good all-around performance and excellent chemical stability.

Investigate the advantages of the Plastolein Plasticizer that best fit your purposes. Write Dept. FE today for *new* descriptive booklet or evaluation samples.



Emery

Organic Chemical Sales Department

Emery Industries, Inc., Carew Tower Cincinnati 2, Ohio

New York • Philadelphia • Lowell, Mass. • Chicago
San Francisco • Cleveland

In Canada: Emery Industries (Canada) Ltd., 639 Nelson St., London, Ontario
Export: Carew Tower, Cincinnati 2, Ohio

SYNPRON STABILIZERS
for
VINYL COMPOUNDS

BARIUM • CADMIUM
ZINC • STRONTIUM
CALCIUM • TIN (STANNOUS)
POWDERS • LIQUIDS • CHELATORS



CUSTOM COMPOUNDING

FOR YOUR SPECIFIC REQUIREMENTS

SYNPRO

40 Years Experience in Metal Organo Manufacturing

SYNTHETIC PRODUCTS COMPANY

1636 Wayside Road · Cleveland 12, Ohio

MOLD STICKING?

USE

REAL-EASE SILICONE

RELEASE COMPOUND

GIANT 20-OZ. CAN



QUALITY: Highest-Uniform
EFFICIENCY: Spray tailored for mold release use.
AVAILABILITY: Stocks in key cities.
ECONOMY: Check these prices.

1 to 11 cans	$1.60 per can
1 to 4 cases (12 cans each)	$16.80 per case
5 to 9 "	15.60 " "
10 to 24 "	14.40 " "
25 or more cases	13.20 " "

DON'T DELAY! ORDER TODAY!

BORCO CHEMICALS INC.
3105 N. Cicero Ave. Chicago 41, Ill.

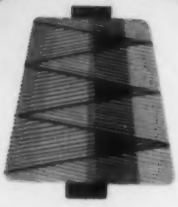
PITTSBURGH

INDUSTRIAL CHEMICALS

for the



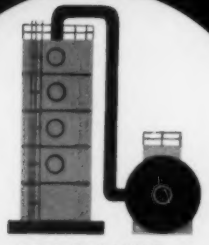
PLASTICS INDUSTRY



TEXTILE INDUSTRY



PAINT INDUSTRY



PROCESSING INDUSTRY

Rx

PHARMACEUTICAL INDUSTRY

P C&C C

INDUSTRIAL CHEMICALS DIVISION
PITTSBURGH COKE & CHEMICAL CO.
PITTSBURGH 19, PA.

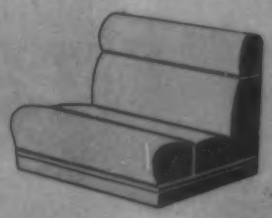
Make PITTSBURGH COKE your "One-Stop" source for Quality-Controlled INDUSTRIAL CHEMICALS!

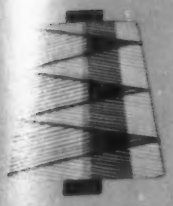
The Industrial Chemicals Division of Pittsburgh Coke & Chemical Company offers you one of the nation's most complete families of coal-derived industrial chemicals and plasticizers.

Now, as always, you enjoy the confidence of doing business with a *basic* producer when you order from Pittsburgh. And Pittsburgh's broad selection of chemicals also offers you these other advantages:

1. A single order for more than one Pittsburgh product simplifies your paper work.
2. By ordering split carload lots of Pittsburgh Industrial Chemicals, you'll enjoy favorable carload prices on *all* of the material you order. Plasticizers can be ordered in split tank cars or tank trucks.
3. The complete facilities of Pittsburgh's Technical Service Department are ready to help you in the application of *any* Pittsburgh product.

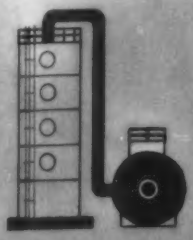
The following listing indicates just a few typical applications for Pittsburgh Industrial Chemicals. Make it *your* check sheet for the reliable, high purity industrial chemicals and plasticizers you need!

INDUSTRY	PRODUCT	TYPICAL USES
 PAINT	Phthalic Anhydride	Manufacture of alkyd resins.
	Toluol	Solvent for lacquers, varnishes and synthetic enamels.
	Maleic Anhydride	Used in the manufacture of alkyd resins.
	Xylol	Used as a solvent in lacquers, varnishes and synthetic enamels, and the manufacture of phthalic anhydride.
	Butyl Oleate	Used in the manufacture of resinous paints.
	Phthalocyanines	Used as a pigment in high finish enamels.
	Fumaric Acid	Manufacture of alkyd resins.
	Decyl Butyl Phthalate	Anti-skinning agent in paint production.
 PLASTICS	Plasticizers	Impart plasticity to polyvinyl chloride and polyvinyl acetate resins.
	Phthalic Anhydride	Manufacture of plasticizers and polyester resins.
	Phenol	In making phenol formaldehyde resins for molding, and in making adhesives and laminating material.
	Ortho Cresol	Reaction agent in the making of synthetic resins.
	Meta Para Cresol	Production of TCP and phenolic-type resins.
	Maleic Anhydride	Manufacture of plasticizers and polyester resins.
	Benzene	Used in the manufacture of phenol and polystyrene.
	Phthalocyanines	A pigment in plastics production.
	Xylenol	A catalyst and reactant in resin manufacturing.
 PHARMA-CEUTICAL	Phthalic Anhydride	Used in the manufacture of phenol phthalein and in cortizone manufacturing.
	Phenol	Disinfectants, germicidal soaps and in the production of salicylic acid.
	Toluene	Production of sulfa drugs, benzoic acids, saccharin and other organic chemicals.
	Pyridine	Used in making penicillin, hormones, vitamins, sulfa drugs and other antibiotics.
	Alpha Picoline	Manufacture of vitamins, anesthetics and germicides.
	Beta Gamma Picoline	In production of nicotinic acid, amide and other drugs.



TEXTILE

Phthalic Anhydride	Textile specialty resins and as dye intermediates.
Maleic Anhydride	Used in the manufacture of dyes and wetting agents.
Benzene	In production of synthetic fibers and dye preparation.
Toluene	Used as a dye intermediate.
Xylene	As a dye intermediate and in synthetic fiber manufacturing.
Pyridine	In waterproofing compounds.
Alpha Picoline	In textile finishing and as a dye intermediate.
Beta Gamma Picoline	In making waterproofing compounds.
Sulfuric Acid	Used in textile finishing.
Ammonium Sulfate	As a fireproofing agent.
Phthalocyanines	In making dyestuffs and as a pigment.

INDUSTRY	PRODUCT	TYPICAL USES
 PROCESSING	**Pyridine**	Used as a solvent, HCL acceptor, and rust inhibitor.
	Sulfuric Acid, **Oleum**	As a processing agent in general industrial applications.
	Phenol, **Maleic Anhydride**, **Benzene**, **Toluene**, **Xylene**	Used as starting chemical for many organic synthetic reactions.

PITTSBURGH INDUSTRIAL CHEMICALS Commercial Data

PHTHALIC ANHYDRIDE
Shipped in 80 lb. bagged flakes and molten in tank cars (100,000 lbs.) and tank trucks (40,000 lbs.).

MALEIC ANHYDRIDE
Shipped in Leverpak drums (250 lbs. net weight).

FUMARIC ACID
Shipped in Leverpak drums (250 lbs. net weight).

PHENOL
99°, 95%, 88-91%, 80-82%. Shipped in drums (approximately 470 lbs. net), tank trucks (4,000 gals.), and tank cars (4,000, 8,000, 10,000 gals.).

ORTHO CRESOL
30° M.P., 31-24C M.P. Shipped in tank cars (4,000, 8,000, 10,000 gals.), tank trucks (4,000 gals.), and drums (approximately 470 lbs. net).

META PARA CRESOL
3° and 12°. Shipped in tank cars (4,000, 8,000, 10,000 gals.), tank trucks (4,000 gals.), and drums (approximately 470 lbs. net).

XYLENOL
3° and 12°. Shipped in tank cars (4,000, 8,000, 10,000 gals.), tank trucks (4,000 gals.), and drums (approximately 470 lbs. net).

BENZENE
Nitration 1°. Shipped in barges (250,000-300,000 gals.), tank cars (8,000, 10,000 gals.), and tank trucks (4,000 gals.).

TOLUENE
Nitration 1°. Shipped in tank cars (6,000, 8,000, 10,000 gals.), and tank trucks (4,000 gals.).

XYLENE
5°and 9°. Shipped in tank cars (6,000, 8,000, 10,000 gals.), and tank trucks (4,000 gals.).

PYRIDINE
2°, 10°, 15°, 20°, 2° shipped in tank cars (35,000 lbs.). Other grades shipped in drums (approx. 450 lbs. net).

ALPHA PICOLINE
Shipped in drums (approximately 450 lbs. net).

BETA GAMMA PICOLINE
Shipped in drums (approximately 450 lbs. net).

SULFURIC ACID
66° Be. Shipped in tank cars (50 tons), tank trucks (18 ton minimum) and barges (750 tons).

OLEUM
Shipped in tank cars (50 tons), and tank trucks (20 tons).

AMMONIUM SULFATE
Shipped unitized, bulk (20 ton min.), and in bags (100 lbs. net).

PHTHALOCYANINES
Dry powder shipped in 55 gal. drums (approximately 100 lbs. net); pressed cake and dispersed paste shipped in 55 gal. drums (approximately 400 lbs. net).

PX PLASTICIZERS
See back cover for full information.

PITTSBURGH PX PLASTICIZERS

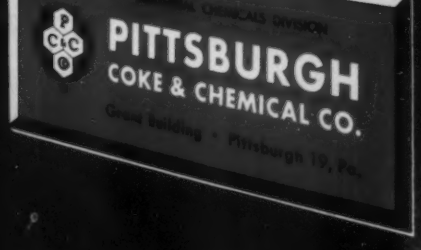
PRODUCT	USES	AVAILABILITY
PX-108 Dilso Octyl Phthalate PX-138 DiOctyl Phthalate	Widely used basic "building type" plasticizers that exhibit an excellent combination of good standard properties.	All Pittsburgh PX Plasticizers are available in 55 gallon drums and in Tank Truck or Tank Car Loads
PX-114 Decyl Butyl Phthalate	A low cost phthalate plasticizer having good standard properties. Ideal for sheeting, tubing, wetting, and general extrusion work.	
PX-118 IsoOctyl Decyl Phthalate PX-120 Dilso Decyl Phthalate PX-800 Epoxy	Economical vinyl plasticizers. Suggested for use where low volatility and a higher degree of permanence is required.	
PX-313 Modified Alkyl Phthalate	Ideal for use in high quality calendering, sheeting, film, plastisols; and because of its low volatility, low temperature flexibility and excellent heat stability, it is equally suitable for wire jacketing.	
PX-208 Dilso Octyl Adipate PX-220 Dilso Decyl Adipate PX-238 DiOctyl Adipate PX-404 DiButyl Sebacate PX-438 DiOctyl Sebacate	For formulations requiring low temperature flexibility, heat and light stability, low volatility and low initial viscosity. Used in vinyl film compounds, polyvinylbutyral and synthetic rubber compounds.	
PX-104 DiButyl Phthalate PX-917 TriCresyl Phosphate	Used in the manufacture of polyvinyl acetate and in nitrocellulose lacquers, synthetic rubber compounds and cellulose ester-type molding compounds.	

WRITE FOR SPECIFICATION SHEETS:

For complete information on uses, specifications, properties and commercial information on any Pittsburgh Industrial Chemical product, write or call for individual specification sheets.

For prompt PITTSBURGH service, call or write:

NEW YORK	485 Lexington Ave.	OXford 7-9050
PITTSBURGH	Grant Building	ATlantic 1-2290
CLEVELAND	420 Bulkley Bldg.	CHerry 1-2170
CHICAGO	75 E. Wacker Drive	CEntral 6-1760
LOS ANGELES	223 East Broadway	CHapman 5-1228



COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

Printed in U.S.A.

IC6-557

FREE

TO SUBSCRIBERS

Modern Plastics' Annual Editorial Index

(Index to Volume 34, September 1956 through August 1957)

You will find this extensively cross-referenced, sixteen-page Index a welcome time saver in locating editorial material that has appeared in a full year's back issues of the magazine. More than that, you'll discover that the Index increases the value of your file copies by providing a considerably more detailed breakdown of their contents—particularly of "buried" references within an article—than is given on the "Contents" page of individual issues.

The Cumulative Index is actually three indexes in one: a General Index of Titles, an Index of Individual Subjects and an Index of Authors.

The General Index of Titles is further subdivided into separate indexes of engineering and technical articles, and the Index of Individual Subjects alphabetically cross-tabs plastics product applications in two ways: by material of composition and by product name.

To get your copy, just fill out and mail the coupon

Modern Plastics,
575 Madison Ave.,
New York 22, N. Y.
Gentlemen:

Please send my free copy of MODERN PLASTICS' Editorial Index for Volume 34.

Subscriber's name .....

Company .....

Address .....

City .....

State .....

RIVERDALE

PRE-LUBRICATED

dry colorants

FOR THERMOPLASTICS

QUALITY
DEPENDABILITY
UNIFORMITY
ECONOMY
SERVICE

make the difference

COLOTROL
RIVERDALE
NEWARK NEW JERSEY

● CALL Riverdale for color matching service

RIVERDALE COLOR CO. INC.

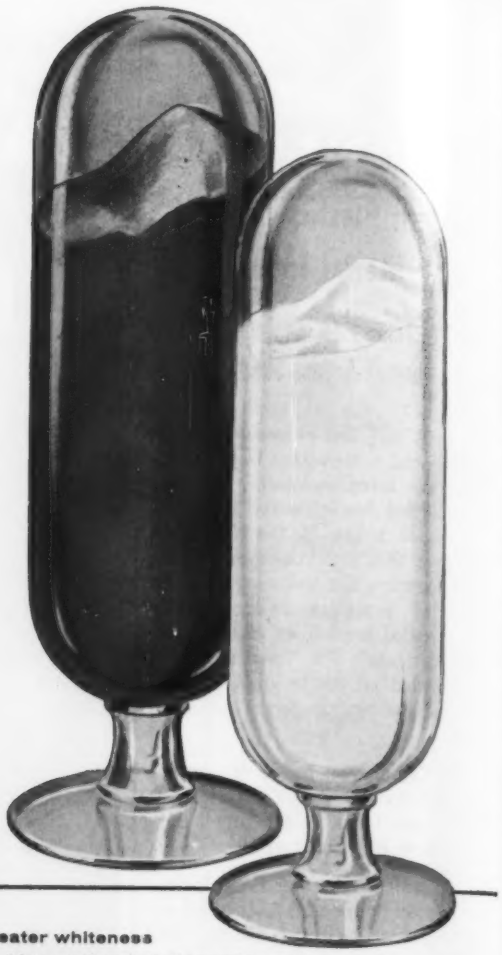
5 Oliver St. Newark 2, N. J. Mitchell 2-3337

Exclusive Export Distributors:

OMNI PRODUCTS CORP. 460 Fourth Ave. New York 16, N. Y.

For pigments for plastics

SPECIFY GLIDDEN



GLIDDEN ZOPAQUE TITANIUM DIOXIDE

- Greater whiteness
- Highly accelerated dispersion rate
- Outstanding gloss
- Excellent hiding power
- Superior color retention
- Low reactivity
- Rutile or Anatase grades

GLIDDEN MERCADMOLITH REDS, CADMOLITH REDS AND YELLOWS

- Soft, easy to grind
- Alkali- and acid-resistant
- Insoluble in all vehicles
- High heat resistance
- Nonfading to light
- Wide range of shades
- Nonbleeding
- Opaque

Write for free descriptive literature and color folder

THE GLIDDEN COMPANY

Chemicals—Pigments—Metals Division

QUALITY Glidden PRODUCTS

BALTIMORE, MARYLAND • COLLINSVILLE, ILLINOIS • HAMMOND, INDIANA • SCRANTON, PA.

All over the Globe . . .

DEPENDABLE COLORS

Dry Colors for

- Injection Molding
- Extrusion
- Blow Molding
- ALL Thermoplastics

Color Pastes for

- Polyester
- Epoxy
- Vinyl
- Acrylic
- Urethane

Finest Colorants
for the
entire Plastics Industry



PLASTICS COLOR COMPANY

22 COMMERCE ST., CHATHAM, N. J. **TEL. ME-5-8600**

Export Agent For Japan
VINMONT & CO.
P. O. Box 503
Palm Beach, Fla.

Midwest Representative
C. J. BERINGER
727 Echo Lane, Glenview, Ill.
Tel. RO 4-4500

Export Agent
HERBERT LORENZ, INC.
299 Madison Ave., N. Y. 17, N. Y.
Tel. MU 2-2674

AVAILABLE NEAR YOU—

PEROXIDE CATALYSTS

...in extensive variety and with many special properties

PEROXIDES

Benzoyl Wet and dry. Free flowing. Fine Powder. Pastes—with stability and less tendency for diluent to separate out. Extremely fine particle size — 25 microns maximum.

Lauroyl Dry and wet with high dispersion qualities.

Methyl Ethyl Ketone (MEK Peroxide) Fast gel time. Every batch standardized.

Chlorobenzoyl

2,4 Dichlorobenzoyl

p-Chlorobenzoyl

CADET CHEMICAL CORP.

HYDROPEROXIDES

Cumene

Diisopropylbenzene

Paramenthane

HERCULES POWDER CO.

TRADE MARK

Technical Bulletins and Samples on Request

Sole Distributors

McKESSON & ROBBINS, Inc.

CHEMICAL DEPARTMENT

155 East 44th Street, New York 17, N. Y.

Atlanta	Denver	Philadelphia
Billings	Des Moines	Phoenix
Bloomfield	Detroit	Pittsburgh
Boston	Hayward	Providence
Bozeman	Houston	Quincy
Brooklyn	Kansas City	Racine
Buffalo	Kearny	St. Joseph
Burlington	Los Angeles	St. Louis
Cedar Rapids	Lubbock	St. Paul
Charlotte	Memphis	San Antonio
Chicago	Milwaukee	San Diego
Cincinnati	Moberly	San Leandro
Cleveland	Mobile	Sioux City
Dallas	New York	Toledo
Danville	Omaha	Wichita
Davenport	Peoria	Williamsport
Decatur	Peru	

"INDUSOL"

LIQUID VINYL PLASTISOLS



A NEW Liquid Plastic That Will Modernize Your Product has been developed in our laboratories. These quality vinyl plastisols sell at exceptionally reasonable prices and we custom tailor to meet rigid requirements in many fields.

Paper and Fabric Coating, Rotational and Slush Molding, Vinyl Foam Compounds, Clay Pipe Joints, Gaskets, Plastic Boot, Rubber footwear compounds, Cloth printing, and flocking adhesive are a few of the many applications. Write now for further information.

INDUSTRIAL SOLVENTS & CHEMICALS, INC.

WILKINSONVILLE, MASSACHUSETTS

Make

MODERN PLASTICS

articles do double duty!

Reprints of articles and features that appear in MODERN PLASTICS are often surprisingly inexpensive when ordered in quantity. Many companies make it a practice to have stories which have a bearing on their business reprinted for distribution to their own personnel, customers, prospects, stockholders, or to other interested groups.

Whenever you see editorial matter of this type in MODERN PLASTICS magazine or the Encyclopedia Issue which you can use in reprint form, in quantities of 100 copies or more, write and quotations will be furnished promptly.

INDUSTRIAL MAGAZINE SERVICE

An Affiliate of Breskin Publications

575 Madison Avenue New York 22, N. Y.

for your vinyl formulations

ARGUS **Mark*** **STABILIZERS**

Mark M	Barium-Cadmium complex (liquid)	heat stability light stability freedom from roll plating protection from sulphur staining retention of physical properties clarity good embossing heat sealing printability freedom from copper staining viscosity stability good impact strength
Mark PL	Zinc complex	
Mark XI	Barium-Cadmium laurate	
Mark XX	Organic chelater	
Mark XV	Cadmium complex	
Mark TT	Barium-Cadmium soap	
Mark E	Strontium Zinc laurate	
Mark X	Alkyl Tin mercaptide	
Mark WS†	Barium-Cadmium complex	
Mark C†	Organic chelater	

†new

ARGUS **Drapex*** **PLASTICIZERS**

Drapex 3.2	Octyl epoxy stearate	low temperature flexibility resistance to soap & water extraction outstanding heat & light aging low volatility • low viscosity good hand
Drapex 4.4	Octyl epoxy stearate (nigh epoxy content)	

*trade-mark

Whatever your vinyl formulation needs,

Argus has the answers—

either in our line products or our research laboratory.

Write for technical bulletins and samples.



ARGUS CHEMICAL CORPORATION / New York and Cleveland

Main Office: 633 Court Street, Brooklyn 31, N. Y. Branch: Frederick Building, Cleveland 15, Ohio

Rep's.: H. M. Royal, Inc., 4814 Loma Vista Ave., Los Angeles; Philipp Bros. Chemicals, Inc., 10 High St., Boston; H. L. Blachford, Ltd., 977 Aqueduct St., Montreal

Thermolite HEAT AND LIGHT STABILIZERS

ORGANOTIN

THERMOLITE 12

For all applications requiring moderate heat stability with good light stability. Excellent clarity in all vinyl resins. Has lubricating properties.

THERMOLITE 13

Powerful heat stabilizer. As an organotin maleate has dienophilic properties and thus prevents yellowing during processing of vinyl compounds at high temperatures.

THERMOLITE 17

A complex organotin stabilizer that imparts outstanding light stability to all vinyls. Heat stability is excellent and gives crystal clear vinyls. Excellent for plastisols and organosols.

THERMOLITE 20

A sulfur-containing organotin stabilizer for rigid vinyls. Has excellent lubricating properties with good heat stability.

THERMOLITE 25

All purpose organotin stabilizer for outstanding heat and light stability. Gives optical clarity in all vinyl resins. For rigids, flexibles and plastisols.

THERMOLITE 31

Most powerful stabilizer known. Unexcelled for rigid vinyls, clear or pigmented.

THERMOLITE 45

Low cost organotin stabilizer with excellent heat and light stability. No water pick-up in clear vinyl hose. For processing copolymer rigids.

BARIUM-CADMIUM

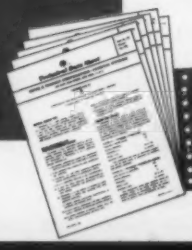
THERMOLITE 112

An entirely new concept in barium-cadmium stabilization. A liquid stabilizer containing no fatty acids or octoates. Outstanding for clear sheeting with no exudation from film — no "plate out" on calender.

LIQUID ZINC

THERMOLITE 166

A liquid zinc stabilizer to prevent sulfide staining. Used with THERMOLITE 112 to give low cost stabilization in all types of vinyl compounds.



DATA SHEETS ON THERMOLITE STABILIZERS AVAILABLE ON REQUEST

TIN & TIN CHEMICALS
CERAMIC MATERIALS
ORGANIC COATINGS
WELDING SUPPLIES
PLATING MATERIALS
METALS AND ALLOYS
HEAVY MELTING SCRAP

METAL & THERMIT CORPORATION

GENERAL OFFICES: RAHWAY, NEW JERSEY

METAL & THERMIT — UNITED CHROMIUM OF CANADA, LIMITED • REXDALE, ONT.

Advertisers' Index

FILM AND SHEETING

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 434.

ACETATE FILM & SHEETING
Campco Division of Chicago Molded Products Corp. 456
Commercial Plastics & Supply Corp. 460
Davis, Joseph, Plastic Company 461
Eastman Kodak Company, Cellulose Product Div. 455
Nixon Nitration Works 459
Scranton Plastic Laminating Corp. 450
Transilwrap Company 465
United Laminations, Inc. 454

ACRYLIC SHEETING
Cast Optics Corp. 452
Commercial Plastics & Supply Corp. 460
Larc Products Inc. 466-A
Scranton Plastic Laminating Corp. 450
Transilwrap Company 465

CELLULOSE ACETATE BUTYRATE SHEETING
Campco Division of Chicago Molded Products Corp. 456
Nixon Nitration Works 459

CELLULOSE NITRATE SHEETING
Nixon Nitration Works 459

EMBOSSING ROLLERS, PLATES
Roehlen Engraving Works, Inc. 448

ETHYL CELLULOSE SHEETING
Campco Division of Chicago Molded Products Corp. 456

LAMINATING & EMBOSSING MACHINERY
Ringler-Dorin, Inc. 466-A

METALLIZED FILM & SHEETING
Coating Products 466

MOLDERS, EXTRUDERS, FABRICATORS
Southern Plastics Co. 457

NYLON FILM, SHEETING, TUBING
Commercial Plastic & Supply Corp. 460
H & R Industries 447

PERFORATING & SLITTING
Perforating Industries, Inc. 458

POLYETHYLENE FILM, SHEETING, TUBING
Campco Division of Chicago Molded Products Corp. 456
Commercial Plastics & Supply Corp. 460
Gilman Brothers Company, The 464
H & R Industries 447
Plastic Horizons, Inc. 449
Scranton Plastic Laminating Corp. 450
Seiberling Rubber Company, Plastics Division 463
Transilwrap Company 465
United Laminations, Inc. 454

POLYVINYL ALCOHOL & CHLORIDE FILMS
Mono-Sol Corp. 458

PRINTING INKS
Atlas Coatings Corp. 458

STYRENE SHEETING
Campco Division of Chicago Molded Products Corp. 456
Commercial Plastics & Supply Corp. 460
Davis, Joseph, Plastic Company 461
Gilman Brothers Company, The 464
Nixon Nitration Works 459
Plastic Horizons, Inc. 449
Portage Plastics Co., Inc. 453
Scranton Plastic Laminating Corp. 450
Seiberling Rubber Company, Plastics Division 463
Transilwrap Company 465
United Laminations, Inc. 454
United States Rubber Company, Royalite Division 462

TEFLON FILM, SHEETING, TUBING
Commercial Plastics & Supply Corp. 460

VINYL SHEETING
Commercial Plastics & Supply Corp. 460
Nixon Nitration Works 459
Scranton Plastic Laminating Corp. 450
Seiberling Rubber Company, Plastics Division 463
Transilwrap Company 465
United Laminations, Inc. 454

Film and Sheeting

Today, virtually all thermoplastics are being used in varying amounts in the films (under 10 mils thick) and sheeting (over 10 mils thick) industry—and the volume continues to grow. As a guide to the many materials available, the following reports have been prepared by the various materials suppliers. For more specific details on the physical properties of the various types of plastics films, consult the Films Chart, p. 559.

SURVEY OF FILM AND SHEETING

The following materials will be covered in this section: vinyls, polyvinyl alcohol, polyvinylidene copolymer, styrene alloys, oriented styrene, polyethylene, the cellulosics, acrylics, polyester, and cellophane.

Vinyls

Because of the diversity of forms in which vinyl film and sheeting are available, this family is generally considered to include plasticized vinyl film and sheeting and unplasticized or rigid film and sheeting. In such instances, the term "vinyl" covers both polymers and copolymers, including polyvinyl chloride and polyvinyl chloride-acetate copolymers. Most of these materials are made by the calendering process. Cast vinyl film, however, in thicknesses ranging from 0.001 to 0.003 in. is also available.[1] The film is designed for use in applications where clarity, chemical inertness, and resistance to moisture vapor and common gases are required. It is finding increasing use in "skin-packaging" applications. The material is not recommended, however, for applications requiring low-temperature impact strength.

A new vinyl film to make a recent appearance has been "hard PVC film"[2]—a completely unplasticized, straight polyvinyl chloride of high molecular weight and with a specific gravity of 1.38. The film is produced on special calenders with highly polished cylinders. Special finishes such as matte or graining are made in subsequent operations. Film is stabilized by a thermal after-treatment.

Hard PVC film has good dimensional stability, wide range of heat stability, no water permeability, low WVTR, wide range of chemical resistance, strong abrasion resistance, and practically no gas permeability. All grades of the material are printable and may be die stamped without any blocking. Unoriented grades of the material may be heat-sealed, vacuum or drape formed, and die or pressure formed. Adhesives and inks used with the film are usual solvent-type vinyl dispersions. The films are recommended for use as tape bases or adhesive releases and in packaging, surfacing, light diffusers, greeting cards, and electrical and chemical insulation.

Plasticized vinyl film[3]

Methods of manufacture: Calendering. In this operation the plastic base material is premixed with suitable stabilizing and plasticizing materials. This premix is then fused in a jacketed Banbury, brought to uniform temperature on a 2-roll mill, and introduced into a 4-roll calender, where it is reduced to the desired gage.

Chemistry: The vinyl chloride plastic base material is made by polymerizing vinyl chloride monomer in suspension or emulsion systems. Ester plasticizers, such as DOP, are normally used to soften the base resin to obtain desired flexibility.

General properties: Moderate tensile strength, high elongation, good tear strength, low water absorption, moderately good chemical resistance.

Processing: Sewn, heat-sealed, or electronically sealed. Special films can be coated with pressure-sensitive adhesives.

Applications: General house-

[1] From Bakelite Co., New York, N. Y.
[2] David S. Greenfield, New York, N. Y., representative for Anorgana G.M.B.H.
[3] Prepared by Firestone Plastics Co., Pottstown, Pa.

ware items; raincoats; shower curtains; closet accessories; furniture covers; lampshades; venetian blind tapes; inflatable items; novelty wallets; pressure-sensitive film applications; shampoo capes; baby pants; mattress and pillow protectors; appliance and equipment covers; braided rugs.

Colors available and methods of finishing: Unlimited range in transparent, translucent, and opaque colors. Can be printed and embossed.

Plasticized vinyl chloride sheet[2]

Methods of manufacture: Same as above for vinyl film.

Chemistry and general properties: Same as above for plasticized vinyl chloride film.

Processing: Can be laminated, heat sealed, or electronically sealed. Special formulations can be coated with adhesive for pressure-sensitive tapes. Special formulations can be formed easily with good shape retention by conventional forming techniques.

Applications: Luggage covering; automotive fabrics; upholstery; flooring; inflatables; pool liners; crash panels (special formulation); pressure-sensitive tapes; novelties; handbags, shoes.

Colors available and methods of finishing: Limited color range in transparent, translucent, and opaque colors. Can be printed and embossed during or after calendering.

Rigid polyvinyl chloride film and sheeting[3]

Methods of manufacture: Calendering. Plastic base material is premixed with suitable stabilizers before being fused in a jacketed Banbury.

Chemistry: The plastic base material used for this type of film is made by polymerizing vinyl chloride monomer or combina-

RECENT DEVELOPMENTS

A bacteriostat (*Corobex,* Bex Industries, Inc.), available as a clear liquid or in powder form, is creating interest among container manufacturers, toy makers, film producers, and molders of hospital and laboratory ware. Products containing the bacteriostat are actively antiseptic, self-sterilizing, and self-deodorizing. They are mildew-static, fungi-static, and mold-static. They are nonpoisonous, nontoxic, and nonallergenic.

A new vinyl chloride film (*Wataseal FD-27,* Harte & Co.) can be used with foodstuffs without trace of odor pickup. It is nontoxic and it has been accepted by the U.S. Food and Drug Administration as a packaging material for food and beverages. Foods that contain a large amount of water can be packaged in this film without drying out.

1957 Fords and Mercurys have from 15 to 20 yd. each of polyester film (*Mylar*) over vinyl, cloth, or paper for welting used as trim on door panels and around seats. Chrysler cars use clear vinyl over a core of woven polyester film (*Mylar*) to give a metallic effect.

Unsupported polyester film (*Mylar*) with a chrome finish is available (Coating Products) in 1-mil stock sheets backed with pressure-sensitive adhesive for nonmoistening applications. It is suggested for the label, decal, point-of-purchase, silk screen, display, and decorative fields. It can be used for outdoor signs and bumper strips without lamination to other materials.

A nylon jersey-backed vinyl upholstery material (*Bolta Continental,* Bolta Products Div., The General Tire & Rubber Co.) is guaranteed against tearing and ripping where approved methods of application have been followed. The material is easy to tailor, can be pulled taut without wrinkling or sagging, and has complete recovery after repeated stretching.

A new calendered rigid vinyl sheet (Bakelite Co.) may be used in direct contact with red meats, poultry, and sea food, as well as other products. Meat and poultry can be dressed and cut at the wholesale point, then shipped in sealed containers with clear tops and placed directly on store shelves. The sheet is easily and inexpensively vacuum formed and can be heat-sealed.

A sterilizable polyethylene food film (*Steripol,* Food Film, Inc.) is less permeable than conventional polyethylene to carbon dioxide, oxygen, and water. The tubing is suggested for packaging frozen foods to be cooked in the package and materials or instruments which would be sterilized in the package.

Unplasticized vinyl film (*Nicotherm,* Ferplex Chemical Co., rep. for Rheinische Gummi und Celluloid-Fabrik), in thicknesses from 1 to more than 20 mils, is colorless and highly transparent. It is continuous-calender-polished and can be obtained oriented or unoriented. The heat resistance for both is about 175° F. The material is suggested for vacuum forming, food wrapping, industrial tapes, and sound recording.

Polyethylene film made from a new high-pressure-processed polyethylene (*Poly-Eth Hi-D 2504,* Spencer Chemical Co.) can withstand temperatures of 240° F. and is two and one-half times stiffer than conventional polyethylene. The resin is about 0.938 density and has good slip characteristics and no blocking. It is less permeable to gases and water vapor and at least three times more greaseproof than conventional polyethylene. It is suggested for use in boilable bags and in various types of overwrap packaging.

A new series of linear polyethylene calendered films (Plastic Film Sales Dept., Kendall Co.) is available in gages ranging from 0.004 to 0.025 in. and widths up to 32 inches. The same manufacturer produces blends of 75, 50, and 25% linear polyethylene with regular polyethylene. Applications will include wire and cable insulation, boilable food packaging, vacuum forming, and packaging where additional thermal properties are necessary.

tions of vinyl chloride monomer with other monomers such as vinyl acetate.

General properties: Good dimensional stability, high tensile strength, low elongation, low water absorption, good to excellent chemical resistance, self-extinguishing. Special formulations available for high light transmission.

Processing: Can be formed by vacuum, plug, ring, or other forming techniques. May be sealed with adhesives to other plastics materials and to itself. Can be coated with pressure-sensitive adhesive.

Applications: Wall covering material; luminous ceilings; louvered doors; packaging; relief maps; lithography; toys; novelties; place mats; waste baskets; shower doors; specialty laminates; wall paneling; Christmas decorations; signs; luminous letters; lampshades; and medical packaging.

Colors available and methods of finish: Almost unlimited range of translucent and opaque colors. Limited range of transparent colors. May be printed and embossed either during or after calendering.

Polyvinyl alcohol film[4]

Methods of manufacture: Band casting. The plastic base material with its modifiers is dissolved in water. This solution, controlled for viscosity and temperature, is then deposited as a wet film on a large moving belt and dried.

Types: There are two types of PVA film; namely, standard and cold water soluble. The standard type is made from the higher-molecular-weight type resins and is generally plasticized with glycerine. The cold water soluble type film is made from internally plasticized resins or low-molecular-weight resins.

Chemistry: PVA film is made from resins which have been hydrolyzed—polyvinyl acetate in the presence of methyl alcohol. There are numerous grades from high viscosity to low viscosity. PVA resin may also be internally plasticized by ethoxylation.

General properties: PVA film is impervious to oils, fats, and waxes and has a zero transmission rate for oxygen, hydrogen, helium, and nitrogen. The water permeability is necessarily rapid, because of the film's being made in water. PVA film has tensile strength which averages about 10,000 p.s.i. before stretching but has shown tensile strengths of more than 50,000 p.s.i. after stretching to 5 times the original length. The elongation of unstretched PVA film may vary from less than 10% to more than 600%, depending upon the plasticizer content and humidity. PVA films have excellent sunlight stability and have stood up in a Fadeometer for over 1,000 hours. The refractive index ranges from 1.49 to 1.53. The aging qualities are excellent with no yellowing. Color is slightly yellow to colorless.

Processing: PVA film readily heat-seals and may be laminated to other films, papers, etc.

Applications: The standard film is used as a relief agent in the molding of polyester resins and vacuum bag molding. The cold water soluble film is used as a water soluble packaging film and barrier coating.

Finishes: Can be made with a satin finish on one side of the PVA film and a glossy finish on the other side.

Polyvinylidene copolymer film[5]

Methods of manufacture: Extruded. Heat extrusion, supercooled, oriented, and blown to gage.

Chemistry: Made from ethylene (petroleum) and chlorine (brine) plus lime plus polymerization with vinyl chloride in presence of a catalyst.

General properties: Excellent chemical resistance. Permeability to water and gases lowest of all commercial films.

Processing: Heat shrinkable; can be laminated with adhesives; will heat-seal (best results obtained if sealed by high-frequency methods).

Applications: Packaging of candies, processed meats, cheeses, baked goods, nuts; also used for cap liners.

Colors available and methods of finishing: Available in a wide range of clear transparent and opaque colors.

Modified styrene/butadiene sheet[6]

Methods of manufacture: Calendering, lamination, and extrusion. The production of modified styrene-butadiene base sheets is accomplished by Banbury or mill mixing and calendering or extrusion.

Chemistry: Series, block, and graft polymerization methods are employed.

General properties: Excellent forming characteristics, good processing, fair impact strength, limited hardness and rigidity.

Processing: Can be formed, sawed, drilled, cemented and polished on standard tools and machinery. Sections can be easily cemented to each other by the following methods: 1) straight solvent and 2) solution cements.

Applications: Refrigerator and freezer liners, housewares, air conditioner housings, battery cases, toys, miscellaneous containers, display items, etc.

Colors available and methods of finishing: Colors: opaque to unlimited (not transparent). Finishes: embossing, gold leaf stamping, printing.

Rubber/resin blends[6]

Methods of manufacture: Calendering, laminating, and extrusion. In the production of styrene alloys, latex blending and/or Banbury mixing are used. Latex blending involves the blending of the copolymer latices. In the alternate method the resin and rubber phases are masticated in a Banbury mixer, extruder, or on mill rolls. Sheets are prepared by calendering and laminating in multi-deck or continuous roller presses.

Chemistry: The resin portion of the blend is made by polymerizing styrene and acrylonitrile monomers. The rubber portion of the blend is made by a similar combining of the butadiene and acrylonitrile monomers.

General properties: Excellent impact strength; high heat distortion; good chemical resistance;

[4] Prepared by Mono-Sol Corp., Gary, Ind.

[5] Prepared by The Dow Chemical Co., Midland, Mich.

[6] Prepared by The General Tire and Rubber Co., Bolta Products Div., Lawrence, Mass.

moderate hardness; fair weathering qualities, and good flexural strength.

Processing: Can be formed, sawed, drilled, cemented, and polished on standard tools and machinery. Sections can be easily cemented to each other by the following methods: 1) straight solvent and 2) solution cements.

Applications: Chemical resistant ducts, automobile headliners, kick plates, crash pads, typewriter cases, refrigerator door liners, tote boxes, trays, miscellaneous housings.

Colors available and methods of finishing: Colors: opaque to unlimited (not transparent). Finishes: embossing, gold leaf stamping, printing.

Oriented styrenes[7]

Methods of manufacture: Extrusion of sheet which is stretched in two directions under accurately controlled temperature to achieve molecular orientation.

Chemistry: Produced from polystyrene or styrene acrylonitrile copolymer as furnished by raw materials suppliers.

General properties: Oriented polystyrene has a tensile strength of 7000 to 12,000 p.s.i., a flexural strength of over 10,000 p.s.i., and a compressive strength of over 25,000 p.s.i. Its % of elongation is 3 to 10. Water absorption (%/24 hr.) is 0.04 to 0.06 mils.

Oriented styrene acrylonitrile copolymer has a tensile strength of 10,000 to 15,000 p.s.i., and a flexural strength of over 15,000 p.s.i. Its % of elongation is 40 to 70. Water absorption (%/24 hr.) is 0.5 (max.).

Processing: Depending upon the application, the film can be slit, die cut, sheeted, pressure formed, and vacuum formed. Adhesives are available, but special handling may be required. It is heat-sealable with special equipment and techniques.

Applications: Oriented styrene is used for packaging, signs displays, and for laminating to high-impact styrene sheet.

Oriented styrene acrylonitrile copolymer is used for packaging, signs, displays, blow-out windows, greenhouses, and outdoor weathering applications.

[7] Prepared by Plax Corp., Hartford, Conn.

Colors available and methods of finishing: Clear transparent and translucent colors.

Polyethylene film[8]

Methods of manufacture: See "Extrusion of Polyethylene," p. 732.

Chemistry: Polyethylene is a pure paraffinic hydrocarbon resin made by polymerizing ethylene gas at high temperature and pressure in the presence of suitable catalysts.

General properties: Good tensile, tear, and impact strength with unusually good performance at low temperatures; low moisture vapor permeability, high gas permeability, low density, therefore high area yield factor; odorless, tasteless, colorless.

Processing: Fabrication by heat-sealing on commercially available equipment. Printing on specially treated types with commercial inks on commercial presses. Pressure-sensitive adhesives can be used.

Applications: Food packaging; soft goods packaging; hardware packaging; moisture barrier in building trades; concrete curing blanket; stratosphere balloons; tarpaulins and agricultural uses, e.g., silo covers, crop mulch, etc.; drum liners; and automotive seat covers.

Colors available and methods of finishing: Natural, black, white, full line of standard colors and pastels; also, embossed.

Cellulose acetate film[9]

Methods of manufacture: A) Casting: In this operation, cellulose acetate flake, plasticizers and other modifiers are dissolved in a suitable solvent; this solution is then deposited as a wet film on a large moving wheel or belt and dried under carefully controlled conditions.

B) Extrusion.

Chemistry: Cellulose acetate flake is made by esterifying alpha-cellulose, under carefully controlled conditions, with acetic acid and anhydride in the presence of a catalyst, e.g., sulfuric acid, washing, drying, and pulverizing. Cellulose acetate flake, plasticizers, and pigments or other modifiers are converted to granules for extrusion by processing on heated rolls or mixed with solvents for the casting process.

[8] Prepared by Visking Co., Div. Union Carbide Corp., Terre Haute, Ind.

[9] Prepared by Celanese Corp. of America, Newark, N. J.

General properties: Crystal clarity; wrinkle resistance; greaseproofness; water resistance; dimensional stability; high gas permeability; good electrical insulation properties; resistance to fogging; and medium water vapor transmission.

Processing: Readily formed by heat; easily fabricated; readily solvent sealed; metalizable; heat-sealable; and easily printed by rotogravure, flexographic, and silk screen printing.

Applications: Prepackaging produce; packaged bakery products; overwraps; window cartons; window envelopes; laminates; electrical insulation; rigid containers; printed signs and displays; book covers; sound recording tape; glazing materials; lamp shades; pressure-sensitive tape; gold stamping foil; protective folders and covers; metalized ribbons; sun shades and curtains; and vacuum formed parts.

Colors available and methods of finishing: Extruded material is available in crystal and in transparent, translucent, and opaque colors. Cast material is available in crystal and in surface-colored transparents. Cellulose acetate film can be finished by printing and embossing, as well as gold leaf stamping.

Cellulose acetate sheet[9]

Methods of manufacture: Extruded. Hot pressing of sheets is used to improve optical quality or to achieve special effects. Laminates, combining two or more colors, are available.

Chemistry: Same as for acetate film, above.

General properties: Same as for acetate film, above.

Processing: Readily formed by heat; readily solvent sealed; easily metalized; can be hot formed, blown, drawn, and solvent stretched; heat-sealable; easily printed; and can be cut, blanked, stamped, stitched, drilled, punched, embossed, laminated, and cemented.

Applications: Machine guards; laminates; electrical insulation; rigid containers; printed signs and

displays; welders' shields and safety lens; glazing materials, truck curtains; protective folders and covers; metalized sequins; sun shades and curtains; vacuum formed parts; book covers; eyeglass frames; and handbags.

Colors available and methods of finishing: Available in crystal, in pearls, and in transparent, translucent, and opaque colors. Can be finished by embossing, printing, and gold leaf stamping.

Cellulose triacetate film and sheet[10]

Methods of manufacture: Cast.

Chemistry: This sheet is made by esterifying alpha-cellulose with acetic acid and anhydride in the presence of a catalyst (sulfuric acid).

General properties: Good flexibility; excellent folding endurance; high heat resistance; low shrinkage; brilliant surface finish; outstanding visual clarity; and chemical stability.

Processing: Good deep-drawing characteristics; readily heat-formed or drawn but not recommended for vacuum forming; and easily high-frequency sealed or solvent sealed.

Applications: Transparent containers; protective sleeves or folders; wallet inserts; overlays; electrical insulation; index tabs; filing equipment; greeting cards.

Colors available and methods of finishing: Clear transparent; matte one side (0.003 through 0.0075 in. only). Readily embossed or hot stamped.

Butyrate film[10]

Methods of manufacture: Cast.

Chemistry: This sheet is made by esterifying alpha-cellulose with acetic anhydride and butyric anhydride in the presence of a catalyst (sulfuric acid); the cellulose ester is given a short hydrolysis to improve its solubility and compatibility.

General properties: Soft; good dimensional stability; low moisture absorption; greater stretch and toughness; long life without loss of brilliance and clarity; and chemical stability (high degree of purity).

Processing: Excellent for lamination to metal foil, paper, and scrim; easily solvent sealed; and easily printed.

Applications: Insulation for wire winding and other electrical applications and metallic yarn.

Colors available and methods of finishing: Clear transparent.

Butyrate sheet[10]

Methods of manufacture: Dry extrusion.

Chemistry: Same as for butyrate film, above.

General properties: Exceptional shock resistance; low moisture absorption; good dimensional stability; unusual ease of forming; superior outdoor weathering resistance. Contains minor surface irregularities and lacks the excellent gage uniformity of cast sheet.

Processing: Excellent for vacuum forming and post-forming; easily high-frequency sealed or solvent sealed; and readily printed, silk-screened, or embossed.

Applications: Skin and blister packaging; advertising displays; outdoor signs; underwater diving equipment; industrial face shields; safety goggles; instrument and radio crystals.

Colors available and methods of finishing: Clear transparent; matte one side; matte two sides; press polished; and transparent and translucent colors on special order. Readily embossed or hot stamped.

Acrylics[11]

There are two types of acrylic sheet available: extruded and cast. Extruded sheet is produced from acrylic solid polymers by a melt process through suitable

[10] Prepared by Eastman Kodak Co., Rochester, N. Y.

[11] Prepared by George Carlyon, Cadillac Plastic and Chemical Co., Detroit, Mich.

TABLE I: Extruded vs. cast acrylic sheet*

	Extruded[1]	*Cast*[2]
Heat-distortion temperature	170	205
Hot-forming temperatures, °F.	230-320	290-360
Tensile strength (ASTM D-638-46T), rupture, p.s.i.	7000	10,500
Flexural strength (ASTM D-790-45T), rupture, p.s.i.	13,500	16,000
Deflection at rupture, in.	0.3	0.6
Modulus of elasticity, p.s.i.	460,000	450,000
Impact strength (ASTM D-256-47), Charpy unnotched, ft.-lbs.	3.2	3.5
Rockwell hardness	M-80	M-93
Refractive index	1.49	1.49
White light transmittance "as received"		
Parallel, %	91	91
Total white, %	93	92
Haze, %	3	2
after 240 hr. accelerated aging		
Parallel, %	90	90
Total white, %	93	92
Haze, %	3	2
Specific gravity	1.18	1.19

* Prepared by George Carlyon, Vice Pres., Mfg., Cadillac Plastic and Chemical Co.
[1] Source: Cadillac Plastic and Chemical Co., Bulletin EX-101, "Fabrication Data of Cadco Extruded Acrylic Sheets."
[2] Source: Rohm and Haas Co., Bulletin 229d, "Physical Properties of Plexiglas."

dic Cast sheet is produced from acrylic liquid monomers by a polymerization process in suitable molds.

The significant differences between cast and extruded acrylic sheet are in strength and resistance to heat. (See Table I, p. 438). Differences in optical properties are slight. Chemical, dielectric, and weathering properties appear to be the same.

Cast sheet is usually recommended where the application requires the maximum in surface finish, clarity, toughness, and heat resistance. Extruded has been manufactured in recent years with much higher quality finish than was formerly the case, and is now acceptable for a wider range of quality finish applications.

In general, fabricating methods and procedures are the same for both cast and extruded materials, except for the following: Forming temperatures for cast sheet run about 35 to 60° higher than for extruded. Recommended oven temperatures for extruded are 260 to 305° F. and for cast, 290 to 340° F. It is not safe to heat extruded above 325° F., or cast above 360° F.

At forming temperatures, extruded sheets are softer than cast and require a greater number of clamps for support. They also have a greater tendency to stick together if touched or folded.

Cementing of extruded materials usually requires a less active or milder cement than for cast acrylics. The soak method of cementing may not be used with extruded materials. Dip and capillary methods are recommended as being more suitable.

Airplane canopies and windows, outdoor signs, and displays are representative uses of acrylics. Acrylics offer optimum clarity and good light transmission. They are strong, rigid, and resistant to sharp blows.

Polyester film[12]

Method of manufacture: Made by flat casting of the polyester polymer and subsequent treatment to produce the polyester film.

Chemistry: Polyethylene terephthalate is the condensation product resulting from the esterification reaction between ethylene glycol and terephthalic acid, or the alcoholysis of a terephthalic acid ester with ethylene glycol.

General properties: It is a clear, tough film (about ⅓ the strength of machine steel), with good elongation and impact resistance. It has very low moisture absorption, is dimensionally stable under extremes of temperature and humidity, with good retention of its physical properties. It has a low moisture vapor transmission rate, its permeability to gases is very low, and it does not embrittle at temperatures as low as −60°C. The film has a high melting point (250-255°C.) and is slow burning. It can be run on packaging machines and heat-sealed with the use of benzyl alcohol. It also has excellent resistance to acids, greases, oils, and organic solvents. Strong alkalies will affect the film, especially when hot. The polyester film has well-balanced electrical properties as measured by its good dielectric strength, high insulation, resistance, and low dissipation factor.

Processing: The film is readily printed, embossed, or delustered. It is used for metalizing and can be laminated to a wide variety of materials. Coatings add to its versatility in making bags and in various packaging applications. It can be run on packaging machines, used as an overwrap, etc.

Applications: This film is successfully used in conveyor belts, transformers, capacitors, motor insulation, insulating tape, wire coating, metallic yarn, as a gas barrier, cartography, magnetic recording tape, and general packaging. In addition, there are many unique industrial uses.

Colors available and methods of finishing: The clear film in roll or sheet form is available from the manufacturer, but processors are now making it available in many colors and special put-ups.

Cellophane[12]

General properties: A relatively tough, transparent sheet. It is hygroscopic, tougher when moist, and more friable when dry. Softeners, such as glycerol, are added to improve its durability. It is difficult to start a tear in cellophane, but once started it tears easily.

It is slow burning, but can be treated to make it nonflammable.

It is not water-vapor-proof as manufactured, but can be made so with coatings. It is grease and oil impermeable. Types that are resistant to liquid water are made.

The film will change dimensionally with changes in relative humidity.

Processing: Cellophane can be printed by all standard processes, formed into bags or overwrapped on almost any package. All types can be sealed by adhesives, and practically all coated types can be heat-sealed to themselves. Standard packaging machines can be used to process the film in the roll form, and semi-automatic machines can be used with sheets.

It can be laminated to other films, foils, and papers to obtain desirable characteristics of both materials.

Applications: The major use for cellophane is in the packaging field as bags, direct wraps, and as overwraps of trays and cartons. It is widely used as a base for pressure-sensitive tape and is used also as a parting sheet in low pressure laminations and in other special industrial applications.

Colors available and methods of finishing: Cellophane is available in a variety of colors, both plain and moistureproof. It can be obtained as sheets, rolls, or in a variety of die-cut shapes. Special types, such as non-moistureproof, semi-moistureproof, and moistureproof are available. Some varieties are heat-sealing, some can be sealed with solvents and/or adhesives. Coatings are varied to provide different characteristics for almost any end use for which cellophane is satisfactory.

References

Consult the Subject Index for additional information on plastic films and sheeting. See also the Plastics Films Chart for information on properties and trade designations. For sources of plastics film and sheeting, consult Directory Index, p. 1018.

"Each item is a special problem

[12] Prepared by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

in packaging plastic products," MODERN PLASTICS *34*, 115 (Dec. 1956).

"Boiled in film," MODERN PLASTICS *34*, 136 (Oct. 1956).

"Plastics at Packaging Show," MODERN PLASTICS *33*, 428 (June 1956).

"Heat-processible food films," by A. I. Nelson, K. H. Hu, and M. P. Steinberg, Modern Packaging *29*, 173 (June 1956).

"Flexible packaging parade," Chem. Week *78*, 90 (June 30, 1956).

"Battery acid in a bag," Modern Packaging *29*, 110 (May 1956).

"Production of rigid thermoplastic sheet," by E. C. Brown, Jr., Plastics Tech. *2*, 226 (Apr. 1956).

"Forming of rigid thermoplastic sheet," by R. C. Davenport, Plastics Tech. 2, 232 (Apr. 1956).

"The first boilable film bag," Modern Packaging *29*, 174 (Mar. 1956).

"The first lined poly tubes," Modern Packaging *29*, 84 (Feb. 1956).

"Plastics films for packaging," Canadian Plastics *1956*, 44 (Jan.).

RIGID SHEETS FOR THERMOFORMING

BY GEORGE S. LAAFF*

Commercially-available formable sheet materials can be classified in broad terms of basic chemical composition. Detailed information, including the producing companies and trade designations, are listed in the Plastics Properties Chart.

A summary of the range of physical, thermal, and electrical properties of the more commonly used formable rigid thermoplastic sheets is presented in Table I, p. 441.

Rigid vinyl

This material is a vinyl chloride/vinyl acetate or similar copolymer, known as "rigid vinyl."

Rigid vinyl has good physical and chemical properties as well as good forming characteristics. It lends itself especially to vacuum and blow molding. The surface of the sheet is usually suitable for printing operations. Large quantities of this material are overprinted with designs and pictures for three-dimensional store displays, ornaments, and the large field of Christmas decorations. The market for rigid vinyl formable sheet in this area is well-established.

Rigid PVC Type I[1]

This classification is also known as UPVC (unplasticized), nonplasticized, unmodified, and normal-impact sheet.

Most PVC has been fabricated using hot-gas welding techniques which are slow and expensive. Heat-forming methods have been used largely to make angular bends. As a cost-saving device, heat-forming is increasingly used.

A peculiarity of unplasticized PVC is that its maximum elongation is reached at approximately 212° F., a point at which it still has fair tensile strength, while its minimum tensile strength is at temperatures above 300° F. Consequently, it is recommended that PVC be formed at temperatures in the neighborhood of 212° F., using high pressures. Forming at higher temperatures with lower pressures may cause rupturing in the mold. Ring-and-plug molding, allowing high pressures, is preferred.

Rigid PVC Type II[1]

This material is modified with acrylonitrile rubber and is referred to also as high-impact, modified, or medium-chemical-resistant polyvinyl chloride sheet.

Rigid PVC Type II has lower chemical resistance than Type I. It was developed for applications where impact resistance is more important than chemical resistance. The heat-forming techniques for Type II are similar to those for Type I.

Styrene-acrylonitrile and butadiene-acrylonitrile

From the standpoint of sheet thermoforming, these materials have a most interesting combination of properties. With excellent physical, chemical, and forming properties, they are used for many applications where clarity or transparency is not essential. The combination of high heat-distortion temperature, high impact strength, good chemical resistance, and embossed-grain retention has resulted in a wide range of industrial applications including boxes and cases, machine housings, interior automotive trim, etc. Their compatibility with fire-retardant resins, combined with low specific gravity, makes them ideal for interior trim in aircraft.

Sheets of resin-rubber blends are formed by vacuum and positive-pressure methods such as blow molding and ring-and-plug, or combinations of all three. Ordinary woodworking tools can be used in all necessary finishing operations.

Styrene-butadiene

This extensively-used material is GR-S rubber-modified polystyrene and is known as medium- and high-impact styrene sheet, depending upon the extent of GR-S rubber modification.

Of the medium- and high-impact sheets, the former is well-known and has been available for many years as extruded sheet. Its great advantage is ease of forming by vacuum or positive-pressure methods. Perhaps its best known application is for refrigerator door liners. The recent development of a high-gloss sheet, produced by laminating an oriented polystyrene film to the surface of extruded sheets, has opened the way to new applications.

High-impact styrene sheet is a more recent introduction to the formable sheet industry. Its applications include those where lower chemical resistance can be tolerated (it is attacked by strong acids and organic solvents).

Cellulose acetate

This material is the product of the reaction of cellulose with acetic anhydride, resulting in a relatively odorless product, which can be cast or extruded into film or sheets of various formulations. Some of its principal physical properties are good toughness and rigidity, formability, and heat and

* Manager, Research and Development, Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass.

[1] U. S. Dept. of Commerce C. S. 20155

solvent sealability. This material, because of its superb clarity, formability, and toughness, finds increasing usage in packaging.

Cellulose acetate butyrate

The chemical composition of this material has long been known. The butyrate radical substituted for part of the acetate improves the physical properties, principally toughness and resilience. CAB continues to find extensive usage in the manufacture of both indoor and outdoor signs. One of the grades, Formula #469, has exceptional resistance to outdoor weathering.

Polymethyl methacrylate

This material is produced by a casting process in which methyl methacrylate is polymerized in step presses. It has a long and distinguished past under tradenames of Lucite and Plexiglas. Du Pont has ceased manufacture of Lucite sheets but still sells materials for casting.

The combination of good physical and optical properties, resistance to weathering, dimensional stability, and ease of heat-forming has been responsible for its extensive use in aircraft for glazing cockpit canopies and also as outdoor display signs. The polymer also conducts light. Although this material has low impact strength, it shatters into chunks rather than shards. All conventional methods of forming and post-fabrication apply.

Polyethylene

Polyethylene sheet in thin gages is widely used as a packaging material because it is an excellent moisture vapor barrier, has good chemical resistance, and has excellent low-temperature flexibility and impact resistance.

Disadvantages of polyethylene are low oxidation resistance which limits its use outdoors, low heat-distortion temperature, and high creep.

Linear polyethylene has been experimentally extruded in sheet form but such sheets are not commercially available today because of unavailability of the polymer. This is one of the materials that offers considerable promise to the vacuum forming industry. The combination of chemical inertness and high heat resistance should fill the need where the presently-available sheet materials have not been satisfactory.

A creditable list of materials, offering a wide range of properties and processes, is available to sheet formers and fabricators today. The fabricator must analyze the requirements and gain complete knowledge of the properties and the optimum fabrication methods for each material.

TABLE I: Physical properties of formable rigid sheets

Property	*ASTM Test no.*	*Rigid vinyl*	*Rigid PVC I*	*Rigid PVC II*	*Styrene butadiene-acrylonitrile*	*Styrene-butadiene*	*Cellulose acetate*	*Cellulose acetate butyrate*	*Polymethyl methacrylate*	*Polyethylene, branched type*	*Polyethylene, linear type*[1]
Specific gravity	792-47T	1.37-1.45	1.4	1.35	1.01-1.09	1.04-1.06	1.30	1.20	1.19	0.92	0.93-0.96
Tensile strength, p.s.i.	638-49T	7000-9000	8500	5700	4000-4500	2200-3400	6500	5550	9000	2000	3000-5000
Flexural strength, p.s.i.	790-49T	12,000	12,000	10,000	5000-6800	5500-6500	7500	6200	16,000	1700-2000	
Flexural modulus, @ 72°F.	256-47T	0.5-0.75	5.0		1.8-2.4	2.5-3.0	2.8	1.35	4.25	0.3	0.75-1.4
Izod impact, ft.-lb./in. of notch p.s.i. × 10^5	790-49T	4.5-5.0	0.8	15	5-10	0.8-6.0	2.8	2.1	0.4	18	1-5
Izod impact, ft.-lb./in. of notch @−20°F.	256-47T	0.2	0.2	1.5	0.5-2.5	0.2-2.5	0.8	1.0			
Heat distortion, °F. @ 66 p.s.i.	648-45T		166	158	180-190	180-190	179	176	221	120	140-155
Heat distortion, °F. @ 264 p.s.i.	648-45T	142-153	162	155	170-180	155-180	162	152	210		
Rockwell hardness, R scale	785-48T	—	110	—	85-90	55-100	97	1.04	M-90	11	35-50
Moisture absorption, % 24 hr.	570-42	0.08	0.05	0.10	0.3-0.5	0.1-0.5	4	1.6	0.3	0.01-0.02	
Dielectric strength, short time v./mil	D149-44	425	700-1000		390	400-500	1100		500	460	500-600
Dielectric constant @ 10^6 cy.	D150-47	3.0	3.0-3.5		2.93-4.35	2.65	4.4		2.5	2.3	2.35
U.V. resistance		Good	Fair	Fair	Fair	Fair	Good	Good	Good	Fair	
Heat formability		Good	Fair[2]	Fair[2]	Good	Good	Good	Good	Good	Good	Good

[1] Not commercially available in sheet form.
[2] Special techniques required.

Laminated Materials

While plastics films offer a diverse range of properties, there is, of course, no single all-purpose material yet available that will answer all requirements. Industry has found, however, that the closest approach yet made to an all-purpose material is available in the concept of laminating two or more films—each with specific desired properties—together. Moreover, by adding other than plastics films, e.g., aluminum foil, paper, cloth, etc., still a wider range of properties and characteristics is possible.

In many instances, even a combination of two materials is not sufficient to meet specialized performance requirements. A third or fourth component is, therefore, added to the laminated structure, e.g., four-web combination of cloth, polyethylene film, Kraft paper, and vinyl film to make the standard type of water-vapor barrier specified by the military.

Types of laminates

The description of a laminated structure is generally applied to a combination of two or more webs joined together by the use of an adhesive layer between the webs. In contrast, a coating would be defined as a substance deposited while in the liquid state on a web without the use of adhesive means. The popular new technique of extrusion-coating seems to fall in the latter category and is generally not considered as a process for making a laminate.

Processing and fabrication[1]

Using the techniques described below, almost all flexible plastics films can be put to use in laminates. The list already includes polyester film, polyethylene, vinyl, saran, acetate, Pliofilm, and there is even talk of nylon. Among the nonplastics materials, the most popular in use in laminations is paper, followed by aluminum foil and fabric cloth.

The desired end properties and requirements govern the selection of materials to be combined and, to an extent, the adhesives and combining techniques employed. Most laminations are made by one of the following methods:

Wet laminations: Adhesives are usually aqueous solutions or dispersions, but solvent cements can also be used. In this method, the adhesive is applied by a suitable applicator roll, the two webs joined under pressure from nip rolls and the solvent evaporated. Laminations of this type require that one of the materials be porous to permit escape of solvent or water vapor.

Thermoplastic: This method is particularly adaptable to laminating nonporous materials. A thermoplastic base adhesive is applied to one web, the solvent is removed by heat, and the second web is joined by pressure from a heated roll. The laminate is then passed over cooling rolls prior to being wound in rolls.

Hot melts: This is one of the simplest types of laminations. No drying chamber is required since there is no solvent to evaporate. The adhesive is applied hot to one web and the other brought in contact while the adhesive is still molten. The laminate is then cooled and wound into roll form.

Contact: Pressure-sensitive or contact adhesives are used by a method similar to the thermoplastic technique. The chief difference is that heat is not required to activate the adhesive. Instead, pressure from nip rolls serves to produce the bond.

Calendering and extruding: Films may be calendered or extruded on flexible webs such as paper, aluminum foil, and other films. While this is not in the strictest sense a laminating procedure, the effect is the same since a multiple web results. The limitations of this process are the types of materials that can be calendered or extruded and the kind of supporting webs that will fit the application requirements.

The selection of the proper adhesive, of course, can have an important effect on the success of the end-use application. A good example is the recent development of the "heat-and-eat" type of package which is fabricated of a polyethylene-to-polyester film lamination. Because of the rigorous requirements of the application, it was necessary to select an adhesive that could take boiling temperatures (when the bag is placed in boiling water during the cooking phase) or sub-zero temperatures (during storage in a freezer) without delaminating.

Applications

The availability of laminates offering a wide range of properties has already started to open up a number of new applications. The "heat-and-eat" application described above (and based on a polyethylene-polyester lamination) is regarded as one of the most important new trends in the packaging industry. Similarly, polyethylene-to-cellophane laminations (polyethylene adds strength and liquid-holding qualities) are responsible for most of the unit- and pouch-packaging of liquid and viscous products.

One of the most exciting developments in recent years has been the application of vacuum protection in a flexible package—and again, the problems connected with this type of packaging could not have been solved without laminated structures. Single films either lacked gas impermeability or could not be used on the special equipment adapted for vacuumizing and sealing.

Materials

Each plastic film has its own special properties to offer to the final laminate, making it possible to engineer a material that can "breathe," hold gases, withstand boiling water, hold fats and oils, be heat-sealable, etc.

Polyethylene, for example, is usually used to impart waterproofness or heat sealability to the substrate and can be combined with such materials as paper, cellophane, polyester film, aluminum foil, fabrics, etc., for use in vacuum packaging meats, for "heat-and-eat" packages, multi-wall bags, sugar pouches,

[1] Prepared by W. P. Andrews, Reynolds Metals Co., 3840 Georgia St., Gary, Ind.

and many similar applications. The polyethylene-cellophane combination has proved especially effective (and is probably the largest volumewise of all the laminates). Cellophane, on the one hand, is a good gas barrier when dry, but has low flex and tear resistance. Polyethylene, on the other hand, is more permeable to gases, but has good flex and tear resistance. Therefore, these materials naturally complement one another and make a good material for vacuum packaging luncheon meats and cheeses, among others.

Pliofilm's positive heat-seal quality, coupled with its flexing properties, makes it a very suitable film for laminations. Pliofilm can be laminated to any of the packaging films, foil, paper, or board stock. Either lacquer-type or water-dispersed adhesives are used to effect strong bonds with satisfactory aging qualities. Acetate-to-Pliofilm, for example, is a lamination that is a good moisture barrier, is durable, grease-resistant, and can be heat-sealed. The combination is especially useful in the packaging of pharmaceuticals.

Even nylon film is showing potential as a possible material for laminate structures. While the film is markedly permeable to water vapors, it has low oxygen permeability, is very tough, and is resistant to hydrocarbons.

Acetate laminations

As an indication of the versatility which the laminates can offer, acetate film can be singled out as an example.

Types of laminates available: Acetate laminated to any one of the following: paper, printed paper and boards, aluminum foil, tissue, fabric, cotton scrim, metal screening, aluminum foil, Pliofilm, polyethylene, saran, or vinyl.

Forms available: Rolls and cut-to-size sheets.

Method of laminating: In the continuous laminating process, the emulsion, lacquer, or hot-melt adhesive is applied to the acetate film and the combination is achieved between heated pressure rolls.

Gage of laminating film: For most applications, the thickness of the acetate film is in the range of 0.00088 to 0.002 inch. On some applications, thicker material up to 0.010 in. is used.

General properties: Good surface appearance, clarity, and depth; increased fold resistance; water resistance; good electrical qualities; and fogging resistance.

By combining with other materials, the properties of the completed laminate can be controlled with regard to moisture vapor transmission, gas transmission, toughness, foldability, etc.

Typical applications: Glazing material; greaseproof barrier wraps; electrical insulations; packaging; adhesive tape base; boxes; labels; book covers; displays; menus; calendars; greeting cards; bags; envelopes; shelf covers; and ribbons.

Finishing methods: Laminates made with plastics films can be finished by embossing, printing, and gold leaf stamping.

Aluminum foil laminates[1]

The two materials that are most commonly combined with plastics films are paper and aluminum foil. Paper adds strength, support, and body to the laminate and is inexpensive. Aluminum foil in the heavier gages is a positive barrier to moisture, gases, and light, and is most effective when combined with films that offer flex and tear resistance and heat-seal properties. Therefore, laminates of the general type, aluminum foil-paper-aluminum foil-Pliofilm or polyethylene, are used for packaging such products as yeast, dehydrated soups, hygroscopic citrus fruit powders, and milk powders. These combinations offer excellent moisture protection, durability, and esthetic qualities. Yeast requires protection from oxygen, so the air in the package is replaced with nitrogen gas. For gas packaging, saran and some types of Pliofilm are more satisfactory as the heat-sealable member of the laminate than polyethylene.

A combination of paper-aluminum foil-polyethylene is used for dehydrated soup and photographic film. Aluminum foil-paper-polyethylene is an excellent material for packaging frozen foods, since it permits them to be reheated by dropping the package in boiling water. Some Mylar-polyethylene is also being used for this purpose.

For packaging headache tablets and effervescent drink tablets, where a high degree of moisture protection is needed, cellulose acetate-aluminum foil-polyethylene or vinyl copolymer laminates are used. The inner film is for heat-seal properties, while the reverse-printed acetate film decorates the package and protects the foil from physical damage which might impair the moisture protection afforded by it.

Paper-polyethylene-aluminum foil-polyethylene combinations are used for gas packaging items such as dehydrated potatoes. In this construction, foil is protected from rupture by the two layers of polyethylene, and, therefore, maintains a gas-tight package. Although it has not been widely used as yet, a laminate consisting of Mylar-aluminum foil-saran gives excellent protection to the passage of gases and should find many applications. This combination is extremely tough, is resistant to greases and chemicals, may be used over a wide range of temperatures, and can be heat-sealed to give a strong bond.

Combinations of cellulose acetate and Pliofilm, acetate and saran, and cellulose acetate and vinyl-coated aluminum foil are used for packaging many pharmaceuticals.

In addition to packaging applications, laminated film products are also used in industrial applications. Metallic yarn is made of cellulose acetate butyrate-aluminum foil-butyrate and Mylar-aluminum foil-Mylar combinations.

Mylar-aluminum foil combinations are used for insulating pipe wrap as are cloth-Mylar-aluminum foil. The foil serves as a vapor barrier and reflective insulator, while Mylar adds flex and abrasion resistance. Mylar is being laminated to vinyl films for use in wallboard and counter and table tops. Many electrical applications are being investigated for aluminum foil-Mylar combinations.

[1] Prepared by W. P. Andrews, Reynolds Metals Co.

Decorating Film and Sheeting

BY GEORGE S. LAAFF*

RECENT DEVELOPMENTS

A high-gloss, water- and oil-resistant ink (*Safe-T-Brite*, Bensing Bros. & Deeney), for flexographic printing of treated polyethylene, polyester film (*Mylar*), and saran-coated cellophane, uses a nontoxic vehicle and a high flash-point solvent. It has the same degree of moisture resistance as impervious coatings, eliminating the need for overprint varnish on films that will be exposed to severe moisture conditions.

A new bonding process (Seiberling Rubber Co.) for adhering embossed polyester film (*Mylar*) to a variety of other rigid and flexible materials (including plastics, pressed wood, steel, and aluminum) is based on the use of a thermosetting adhesive, plus a special combination of time, heat, and pressure. Sheet metal can be shaped after the surfacing has been applied. Anticipated applications include coverings for radio cabinets, air conditioners, refrigerators, and other household appliances.

A stock range of vinyl fabrics (Goodall-Sanford, Inc.) is engineered and styled for the seat cover field. An unsupported vinyl (*Goodallite Coronado*) is available in 10 colors, and a cotton knit supported vinyl (*Goodallite Readington*) is offered in 14 colors.

A line of vinyl-cloth laminations (Scranton Lace Co.) consists of plain, printed, and embossed vinyl sheet laminated to drills, twills, cotton knits, sheeting, nylon backing cloths, and other fabrics. Applications include luggage, beach umbrellas, tarpaulins, and outdoor furniture, as well as baby carriages.

The most common methods used today to decorate plastics film and sheeting are embossing and printing. (See Table I, p. 445.)

A variety of effects can also be achieved by *laminating* plastics films to colored sheets or to fabric, paper, or foil. By sandwiching decorative fillers, e.g., natural or synthetic flora and fauna, fibers, fabrics, etc., between two transparent sheets in a laminate, an unlimited number of imaginative designs can be created. Certain thin transparent films, e.g., oriented styrene, can also be printed on their reverse side before being laminated to heavier plastic sheeting.

The quilting of film and sheeting (or other decorative effects) may be accomplished by high-frequency *sealing* or *stitching* two pieces of material together, using foamed plastic, paper, or natural or synthetic fiber waddings as the interlayer.

The *flocking* of colored fibers on film and sheeting offers still another way of enhancing appearance. Reportedly, in many applications, the film or sheeting can be flocked either before or after the fabrication process takes place.

Attractive effects may also be imparted to film and sheeting by the *addition of materials during compounding*, e.g., fish-scale extract for a pearl effect, or metallic powders for a lustrous sheen.

Metalized film and sheeting is another material that offers decorative possibilities. Metal effects can be obtained, for example, by laminating metalized Mylar to vinyl film and sheeting.

Ruffling and *crimping* may also be used to improve the appearance of fabricated items.

EMBOSSING PROCESSES

The art of forming surface patterns in relief by embossing a design into the material is widely used to decorate and increase the utility of both film and sheeting. Embossing is usually accomplished by one of two principal methods: plate or press embossing, or roller embossing.

Surface designs in relief may also be obtained in cast film by reproducing the surface on which the film is cast. Two methods are used: 1) evaporation of differential solvents, and 2) exposure of the film or sheeting to electronic waves to get a crinkled effect.

Plate embossing

Commonly used for producing alligator and similar deep-grained patterns in vinyl sheeting, plate embossing is performed with heated mechanical or hydraulic flat-bed presses. In this process, a metal plate engraved with the desired pattern is clamped to the upper platen of the press. The upper platen is heated either by steam or high-pressure hot water. The matrix, or female embossing plate, is fastened to the bottom platen which is not heated. The matrix is a soft, fibrous sheeting which is usually made of paper or felt formed to the necessary contour by wetting and then pressed against the embossing plate.

Most quick-acting presses are built with stationary top platen

* Manager of Research & Development, Bolta Products, a Div. of General Tire & Rubber Co., Lawrence, Mass.

Recent Developments and References were prepared by the editors.

The author wishes to acknowledge the assistance of the following individuals in the preparation of this chapter: H. S. Vohs, Roehlen Engraving Works; Dr. G. F. Goldstein, Interchemical Corp.; D. G. Higgins, John Waldron Co.

and movable bottom platen. Sheets or continuous rolls of stock are fed mechanically or by hand into the press and positioned between the engraved plate and the matrix. The press is closed for a period of time necessary to achieve permanent embossing, which may vary from a few seconds to 1 minute. Film and sheeting subjected in this manner to mechanical pressure and heated to their flow points, take on the contours of the engraved plate. Temperature, pressure, dwell time, and the quality and depth of the engraving are all critical factors in satisfactory embossing.

In limited applications, heated plastic sheets are embossed with coarse textured cloths, wire screens, woven rattan, or similar materials. Plate embossing is generally satisfactory for short runs and embossing of small sheets.

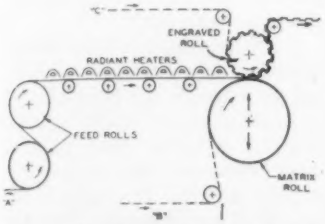


Fig. 1: Radiant preheated embossing roller laminator

In production embossing of continuous film and plastic sheeting, the resulting plate marks or overlaps are objectionable and roller embossing is preferred.

Roller embossing

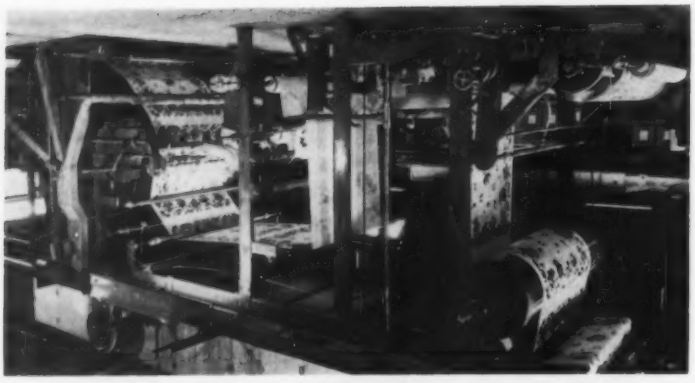
Generally used for shallow and deep grain embossing such as skiver, box calf, moire, etc., the roller embosser (Fig. 1, above) operates on the same general principles as the flat-bed press, except that the design is engraved on the surface of a steel roll instead of a flat plate. Heated plastic film or sheeting is passed between the engraved roll and a backing or matrix roll.

Formerly, matrix rolls were made of pressed paper, cotton, or wool, but almost all of the rolls in current use are rubber rolls. The density or hardness of the backing roll is dependent upon the depth of engraving in the steel embossing roll. Usually, high-density rolls are used for shallow patterns and low-density rolls for deep patterns. Paper matrix rolls are saturated with water and then brought into intimate contact with the engraved roll to "run in" or "cut in" the design of the engraving. This reproduces a counter impression of the engraving in the bed roll which contributes toward clear, well defined embossed designs.

The amount of heat and pressure applied varies considerably; it is dependent upon the nature of the material to be embossed, thickness, pattern desired, and

TABLE I: Summary of processes for decorating film and sheeting

Process	*Special purpose or advantage*	*End use*
Plate embossing continuous sheets	Deep embossings.	Alligator embossed PVC sheeting for the shoe & handbag trades.
Plate embossing sheets	For short runs and small sheets.	Place mats, tablecloths, handbag and shoe materials.
Roller embossing	For more reasonable production rates.	Upholstery and automotive materials.
Vacuum embossing	Specialty embossing, short runs, deep draws.	Novelties and automotive.
Rotogravure printing	Fine detail in printing. Many different colors. High rate of production.	Shower curtains, cottage sets, dinette material, upholstery, and automotive.
Surface printing	Imparts 3D properties, hand-painted effects.	Shower curtains, tablecloths, cottage sets.
Topping	Two-tone effect.	Handbags and shoes.
Flexographic printing	As many as 6 colors printed continuously. Low-cost engraving.	Inflatable toys.
Spanishing	Two-tone effect on embossed material.	Handbags and shoes.
Valley printing	Simulates fabrics.	Upholstery, automotive, wall covering.
Transfer printing	Multi-color design on small pieces. Excellent detail and register.	For cards and novelty items. Products where excellent registration is required.
Laminating metalized film to vinyl film and sheeting	Simulated metal finishes.	Automotive interior trim, shoes, handbags, and novelties.
Sandwiching decorative media between transparent film and sheeting	Decoration with natural or abstract figures and designs (flora and fauna, strands, fibers, fabrics).	Novelties.
Stencil printing (plastisol island printing)	Unlimited design possibilities. Moisture vapor transmission imparts seating comfort.	Automotive and furniture upholstery.



Vinyl film, printed by the gravure process in multi-color, is later embossed and slit into tablecloths. (Photo, General Tire & Rubber Co.)

speed at which the operation is performed. As a general rule, deeper patterns require greater heat and pressure. Since the plastic sheeting must be cooled to set the impression, embossing is generally accomplished by using a cold engraved roll with plastic film or sheeting that has been preheated.

Low-pressure roll embossing

There has been a decided trend toward a method commonly known as low-pressure roll embossing. In this process the plastic sheeting is heated to a temperature between 250 and 340° F. and passed between the metal embossing roll, usually of thin-walled shell construction, and a rubber roll slightly larger in diameter. The steel roll is internally cooled by brine or circulating cold water. The rubber roll is cooled by immersion in a trough of running cold water. To avoid blisters in the sheeting, excess water is removed from the surface of the rubber roll before contact is made with the vinyl film. This is accomplished by use of squeeze rolls, rubber wiper blades (squeegees), air knives, or a combination of methods.

Most low-pressure installations have a heating table arrangement varying in length from 4 to 8 feet. The plastic sheeting, supported on a conveyor, passes underneath and in very close proximity to radiant heaters. Such a conveyor is essential in the handling of unsupported film. It is of utmost importance to have the heating arrangement as close as possible to the nip of the embossing rolls in order to prevent cooling of the material before embossing. After the plastic sheeting leaves the embossing rolls, it passes over one or a combination of several cooling drums.

The compactness of this type of embossing enables tandem operation with coating or calendering equipment. The plastic can be embossed directly off the calender or organosol-plastisol coating machine, since at this point the plastic material is most receptive to low-pressure embossing.

Great strides have been made in embossing *off* the calender, with the low-pressure embossing unit mounted as close as possible to the last calender roll. At a minimum distance, an optimum embossing condition exists when the vinyl film is coming off the calender at its true softening or flow point. If the embossing unit cannot be mounted sufficiently close to the calender, additional heating equipment must be provided to maintain the softening temperature. Patterns pressed into vinyl film and sheeting at high pressure but at temperatures below the true softening point of the film lack permanency and adversely affect the dimensional stability and strength of the sheeting. In high-speed production, higher mechanical pressures and temperatures are needed to achieve optimum physical properties. It is good practice to carry the film around the embossing roll as far as possible in order to increase dwell time.

Most of the difficulties encountered in embossing off the calender are caused by unsuitable rubber rolls. High operating speeds and, more especially, extremely high temperatures and plasticizer vapors rapidly deteriorate rubber rolls, causing costly production delays. Special types of rubber, varying densities, etc., have alleviated production shutdowns. In postcalender embossing, as well as other low-pressure operations, the rubber roll is usually gear driven while the steel roll is driven by contact only.

Embossing *on* the calender is the latest development in this field. In this process, the vinyl sheeting is embossed directly against the last calender roll instead of against an auxiliary rubber covered roll. This method is very limited and is extremely difficult to perform.

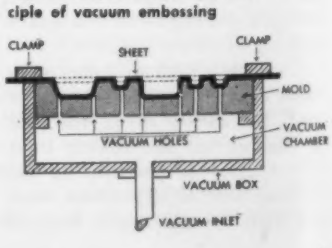
An increasing number of manufacturers are embossing directly *off* the calender due to advantages in cost and ease of operation. This method is highly economical in long production runs as the speed of the calender is geared to the speed of the embosser. Frequent roll changes, however, seriously impede the calender efficiency. A low-pressure embossing machine, built to accommodate the same embossing rolls used in *off* calender embossing, provides versatility without additional roll costs.

Additional fine decorative effects are achieved by inlay or ink embossing where inks are transferred from the high points of the engraving into the valleys of the embossed pattern.

Vacuum embossing

The newest technique for film or sheet embossing is vacuum embossing (Fig. 2, below). Polyethylene or vinyl films are drawn against an engraved plate or a mold provided with suction holes

Fig. 2: Diagram showing principle of vacuum embossing



or a textured fabric which is against a perforated steel plate attached to a suction device. The film, at its flow-point temperature and under atmospheric pressure, readily accepts the texture of the engraving or the fabric. This process is applied to single sheets or continuous rolls for place mats, tablecloths, handbags, etc.

PRINTING INKS

Printing inks for decorating plastics film and sheeting are composed of colorants dispersed in a resin binder. Since the surfaces of plastics film and sheeting are nonporous, the principle of printing differs from that which is ordinarily employed for paper, textiles, and other materials having absorbent surfaces.

Most inks used contain volatile solvent and a binder of the same general type resin as the film to be printed. When the ink strikes the film, the solvent partially dissolves the film surface at points of contact and, upon evaporation of the solvent, the surface dries with the pigmented binder as an integral part of the film. This process is limited to films for which solvents are commercially available. There are also aqueous dispersion inks available which do not dissolve the film but become an integral part of the film after they have been thoroughly dried.

Special surface preparations, such as the Kreidl process, are necessary for satisfactory ink adhesion to polyethylene.

The following are two typical examples of printing ink formulations for polyvinyl chloride flexible sheeting:

1) Inorganic pigment (as listed previously)	32%
Resin binder (polyvinyl chloride acetate copolymer and/or other resins	13%
Solvents (ketone type)	55%
2) Organic pigment such as phthalocyanine green or blue (as listed previously)	7%
Resin binder	10%
Solvent	83%

The pigments generally used in the vinyl inks are: White—titanium dioxide, calcium carbonate, calcium sulfate, barium sul-



Good embossing starts with

superior quality rollers and plates.

When you emboss from

Roehlen rollers and plates

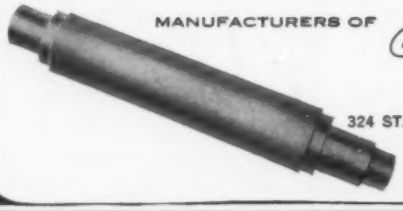
you are sure of

the best possible embossing,

valley printing, tipping and shading.

ROEHLEN ENGRAVING WORKS, INC.

MANUFACTURERS OF *Embossing Rollers and Plates*



324 ST. PAUL ST., ROCHESTER 5, NEW YORK

Do you know all the latest ways to cut your packaging costs?

Are you familiar with new developments in package design that stimulate retail sales?

Are you sure you're using the best kind of package to protect your product from damage?

If you had to answer "No" to any one of these questions, it's likely that you're unnecessarily losing money every business day.

Fortunately there's an easy way out: MODERN PACKAGING magazine! It's the world's most authoritative publication devoted exclusively to packaging problems and their solutions. It analyzes all of the newest developments in packaging—materials, machinery, design and production. It reports each of the latest ways to merchandise packaged products of all types, from frozen foods to monkey wrenches.

The cost of an annual thirteen-issue subscription—including the giant annual Encyclopedia Issue—is only $7.00 in the U.S., its possessions and Canada; $20 elsewhere. You can begin yours today simply by writing us on your business letterhead. We'll bill you later.

MODERN PACKAGING
MAGAZINE
575 MADISON AVENUE,
NEW YORK 22, N. Y.

fate; Black—carbon black, lamp black, bone black; Red—calcium and barium salts of permanent red 2B, lithol rubine, cadmium selenide, iron oxide; Green — phthalocyanine green, light chrome green; Yellow — chrome yellow, chrome oxide; Orange—molybdate orange, iron oxide, and cadmium sulfide; and Blue—phthalocyanine blue, ultramarine blue, iron blue.

PRINTING PROCESSES

The most important method of printing film and sheeting utilizes engraved rollers since continuous, high-speed production is desired. Three types of rollers may be employed: 1) solid copper shells, which are the most economical for reproducing designs with small "repeats," 2) copper-plated steel cylinders, which are more practical for larger areas, and 3) steel rolls or cylinders.

Copper or copper-plated rollers may be engraved by three methods. The *die and mill process* is used to engrave patterns having very small or no "repeats," such as fine checks and continuous stripes. The *pantograph process* is employed to reproduce designs of variable area coverage, up to 100%, or a combination of solid and half-tones. The *gravure process*, or photoengraving, is the most important method of engraving since excellent detail in reproduction of art-work is obtained. A complete range of tones can be printed by the latter method which results in clarity of fine detail and unusual photographic effects; multi-color printing is possible by using three or more rollers.

Gravure printing

The most widely used method of printing both heavy- and light-gage vinyl film is gravure printing (Fig. 3, p. 450). It consists of depositing ink onto the surface to be printed from the recesses of a photoengraved plate or cylinder. The pattern to be printed is etched into the metal in the form of small cups. Gravure screens vary in size from 75 to 300 lines per inch.

In the printing operation, color



RARITAN PLASTICS CORPORATION

Division of Plastic Horizons, Inc.
1 Erie Street, Paterson 1, New Jersey
N. J. Phone: AR 4-6874
N. Y. Phone: LA 4-5387

High impact polystyrene, polyethylene, and other plastic sheets for vacuum forming, fabricating, general industrial applications.

Custom laminating of plain, industrial, or decorative material.

Polyethylene film with highest sparkle, clarity, slip and strength to fit your exact requirements.

Sizes up to 60" wide
(tubing to 60", edge slit to 120")
All gauges, down to .0005"

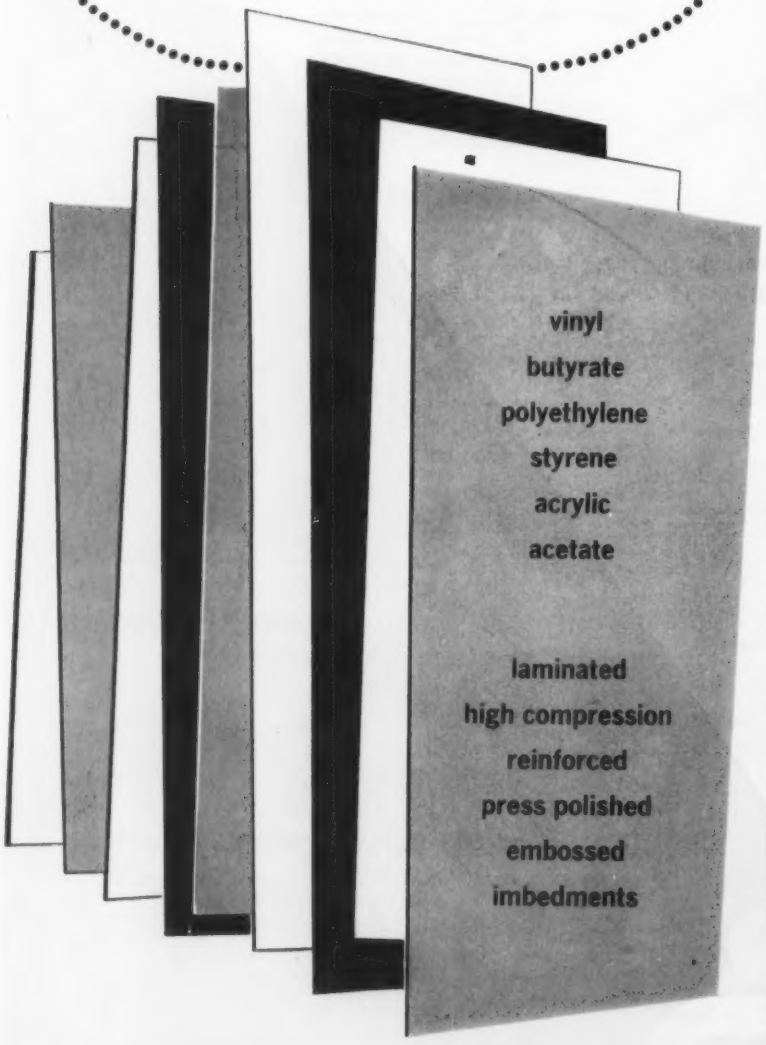


PLASTIC HORIZONS, INC.

2 East 5th Street, Paterson 1, New Jersey
N. J. Phone: AR 4-6874
N. Y. Phone: LA 4-5387

Rigid plastic sheeting

for every purpose



Stock sizes up to 51"x 108".

Available transparent, translucent, or opaque—in a wide range of colors.

Scranton Plastic Laminating corp. 3218 PITTSTON AVE., SCRANTON 6, PA.

is delivered to the cells by contact with a furnish roll or by immersion of the lower portion of the print roll. Excess color above the level of the cells as well as on unengraved areas is removed by a sharp, thin knife-edge doctor blade pressing against the engraved cylinder surface. The "doctored" roll, containing a measured amount of ink in the engraving, is brought into contact, under pressure, with the surface of the film or sheeting to be printed and the ink is transferred from the engraving to the film.

Gravure printing machines are available for printing patterns with one to twelve colors. Variations in depth of color from a single engraving are possible through differences in depth of engraving. By limiting the quantity of ink deposited through the use of a shallow engraving, the color of the film may be allowed to show through and change the tone of the printed color.

Due to lack of absorbency of plastics films, surface drying is necessary between print cylinders. The areas printed first will, on reaching the next position on the print machine, be in contact with the smooth unengraved portion and, if the ink is not dry, smudging will result.

Typical examples of gravure printing include shower curtains, dinette sets, tablecloths, and cottage sets.

Over-printing is a form of gravure printing. In this method, a yellow pigment is printed first, then a red, and finally a blue. A multi-colored effect is obtained by varying engraving depths. The yellow, usually a chrome pigment, must be opaque in order to hide completely the color of the film on which it is printed. The red and

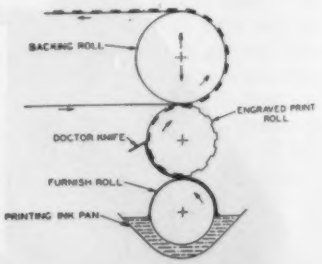


Fig. 3: Schematic drawing of gravure printing process

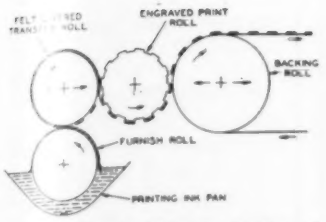


Fig. 4: Schematic drawing of surface printing process

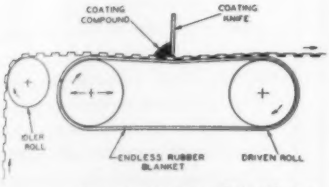


Fig. 5: Diagram of "knife-on-blanket" spanishing unit

blue, however, must be as transparent as possible in order to take full advantage of the light filtering effect.

Reverse printing is another form of gravure printing. In this process, the ink is applied to the reverse side of a transparent film. Usually, the application is on heavy-gage film used for upholstery applications where abrasion resistance is important. Multi-color patterns with a solid background are obtained by first printing the pattern, then a solid color blotch over the printed pattern. Maximum opacity is, of course, necessary for all the pigments used in this process.

Surface printing

The surface printing process (Fig. 4, above) is adopted from wallpaper printing. Three-dimensional effects may be obtained and up to 12 colors may be used. The engraved pattern is raised about 3/16 in. above the core of the roll instead of being recessed as in gravure printing. The raised engraving permits application of a large number of colors by continuous process without smudging. Drying is not required between print nips.

Color is furnished to the raised engraving by a covered transfer roll, which is color-fed by surface contact with a metal roller immersed in the ink pan. The wet layer of ink on the engraving, about 2 mils thick, is transferred to the film by "kiss" printing with a minimum of pressure. Excessive pressure produces a so-called "back-lash" which is an undesirable large ring or halo around each pattern. A *small* halo, however, is desirable since it imparts a three-dimensional as well as a hand-painted effect. This type of printing is widely employed for plastics drapes, place mats, and shower curtains.

Spanishing

This method, commonly used by the leather industry, has been adapted for use by plastics film and sheeting converters. The ink is wiped into the valleys of embossed film or sheeting by either "knife on blanket" (Fig. 5, left), or by "wipe roll" (Fig. 6, below), machines. This method of finishing was the precursor of "valley printing" described below. It is widely used for handbag, belt, and shoe applications.

Tipping or *topping* produces a two-tone decorative effect inverse to "spanishing"; i.e., the high points, instead of the valleys, of the embossed film or sheeting are inked. Neither "spanishing" nor "topping" produces very elaborately decorative finishes and these processes are slowly yielding to flexographic printing and valley printing.

Flexographic printing

Formerly known as aniline printing, flexographic printing (Fig. 7, right) is not widely practiced on vinyl film but has proved successful for the processing of specific items. Inks used in flexographic printing must not attack rubber rollers or rubber engravings. Consequently, practical considerations limit the application to alcohol and water inks. A method of printing water-soluble inks with subsequent solvent resin topcoating has proven successful. The type of engraving used in a flexographic press is similar to that used in surface printing except that the rolls are made of rubber. The raised engraving in the flexographic process makes it possible to print up to six colors continuously. Inflatable toys and other seasonal or disposable items are suited for this type of printing due to the low cost and ease of cutting or molding rubber engravings.

Valley printing

One of the newest methods developed for printing film and sheeting is valley printing (Fig. 8, p. 452), which consists of simultaneously embossing and printing. In one operation, the color is furnished to the peaks of the embossing roll and deposited into the valleys of the embossed sheeting. Valley printing produces unusual two-tone effects in elaborate floral designs and simulation of fabric surfaces. This new decorative technique offers a refreshing approach to decoration of vinyl sheeting.

Rubber rolls must be used to furnish ink to the high points of the embossing roll, restricting inks to alcohol- or water-soluble types. The ink is applied to preheated film or coated fabrics and maximum adhesion and water resistance is developed after aging for several days. Water inks have proved more resistant to cleaning solutions and general wear.

Transfer printing

A method consisting of printing on a carrier material and then transferring the print to a film is called transfer printing. It is normally accomplished by printing

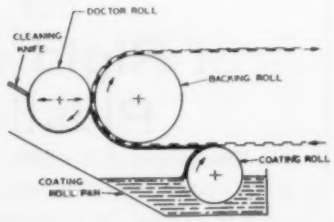


Fig. 6: Diagram of wipe-roll spanishing operation

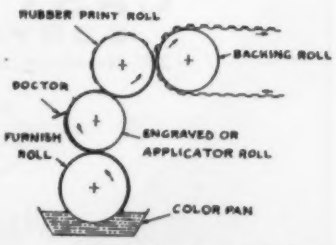
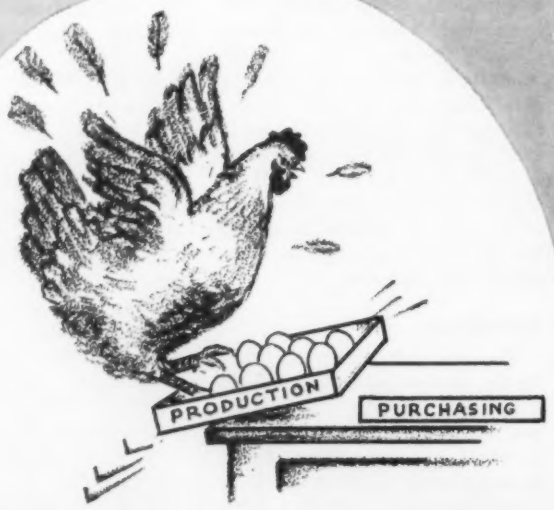


Fig. 7: Setup for using flexographic printing process



It's Dangerous to have all your eggs in one basket!

Placing all your orders like neatly-arranged eggs into one basket is begging for trouble in this day of tight production schedules. If you depend on prompt delivery of rigid cast acrylic sheets to keep your production wheels turning, an additional source of supply is as essential as your machinery. More and more firms throughout the country find the Cast Optics Corporation a reliable source of Cast Acrylic Sheets — whenever they need them and in any quantity they want. Cast Optics Corporation specializes in producing optically clear, rigid plastic sheets of the highest quality — durable, abrasion resistant and cast to closer thickness tolerances. Get in touch with us today!

We are manufacturers...
not jobbers
of Rigid Cast Acrylic Plastic Sheets

Thicknesses .030 - .500 **Sheet sizes up to 48"x72"**
First grade or S-grade available in clear or translucent white
CR39 — ideal for instrument windows and other uses. If you are a fabricator, jobber or end user, contact us for immediate delivery from stock.

CAST OPTICS CORPORATION
300 Newman St., Hackensack, N. J.

Manufacturers of COCOR • BRAND Plastic Sheets

COCOR® Registered Trademark of Cast Optics Corp.

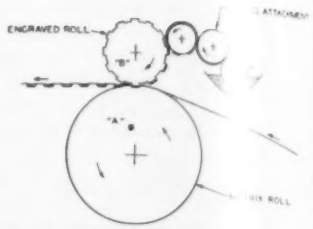


Fig. 8: Valley printing produces unusual two-tone effects

either a single or multi-color design on a special paper coated with methyl cellulose, melamine- or urea-formaldehyde resin, or an alkyd. The printed paper is placed in intimate contact with a film or is used as a surface onto which a film is cast. In either case the print releases from the paper and becomes an integral part of the film. The film, when stripped from the paper, bears the permanently transferred design. Special inks are used for ready print release. Excellent detail and register are obtained since the paper has minimum stretch.

Letterpress printing has limited use in the decorating of plastics film and sheeting, but is worthy of mention for its use in printing and decorating plastics credit cards, calling cards, and novelty items.

Stencil printing

The method of flat stencil printing is a hand or semi-automatic process and has the advantage that smaller yardages or short runs can be printed economically. Changing of the pattern can be executed more quickly than in the case of machine printing. The designs, usually ranging from 24 to 48 in. in repeat, are die-punched through a flat copper or stainless steel sheet which is attached to a rigid metal frame.

The fabric is pinned onto the padded surface of a long table and stencil printed in successive "strikes" at predetermined repeat "stops." Plastisol is fed into the unperforated border of the stencil which acts as a reservoir and is transferred through the openings in the stencil onto the fabric by moving the plastisol across the stencil with a hand-operated "squeeze" or scraper.

Multi-colored effects may be

obtained by using a separate stencil for each color of plastisol to be printed.

Screen printing, a form of stencil printing, is the oldest and least important printing method. The design is produced by passing the ink through unmasked areas of a silk or nylon bolting cloth mounted on a wooden frame. The main advantage of this method lies in the low cost of patterns or screens. This is offset, however, in large-scale production, by labor and handling requirements in that it is usually a hand process or, at best, only semi-mechanized.

Plastisol island printing

Discontinuous deposition of pigmented vinyl dispersions onto supporting fabrics of natural or synthetic fibers offers novel styling possibilities. The effective moisture-vapor transmission thus obtained (through the noncoated areas) also provides improved body comfort. Post-embossed graining, color topping of the plastisol islands, or the use of fabrics incorporating metallic or plastic yarns offer further design possibilities.

In the plastisol island printing process, the vinyl plastisol is deposited through the perforations of a flat metal, paper, or plastic stencil (*table printing*) or through the cut or punched perforations of a copper or steel cylinder (*continuous roller stenciling*). The thickness of the plastisol deposited ranges from 0.005 to 0.030 in. and normally covers from 50 to 75% of the fabric area.

The stenciled fabric is then passed through an oven for fusion of the plastisol. The temperature necessary is determined by the thickness of the deposit and the time it will be subjected to cure. Fusion temperatures generally range between 375 and 450° F. The supporting fabric, of course, must not be subject to distortion at the fusion temperature of the plastisol.

Top coating

In current practice, printed and embossed film and sheeting are coated with a clear resin solution principally to provide protection against wear and to promote cleanability. A wide range of



PLASTIC SHEETING IN STOCK

CUSTOM VACUUM MOLDING

Portage Plastics has plastic sheeting available in stock, in 6 colors, natural, white, yellow, red, blue and black. Orders on standard stock filled from inventory promptly. Minimum order of 50 lbs. accepted, gauges range from .010″ to .187″.

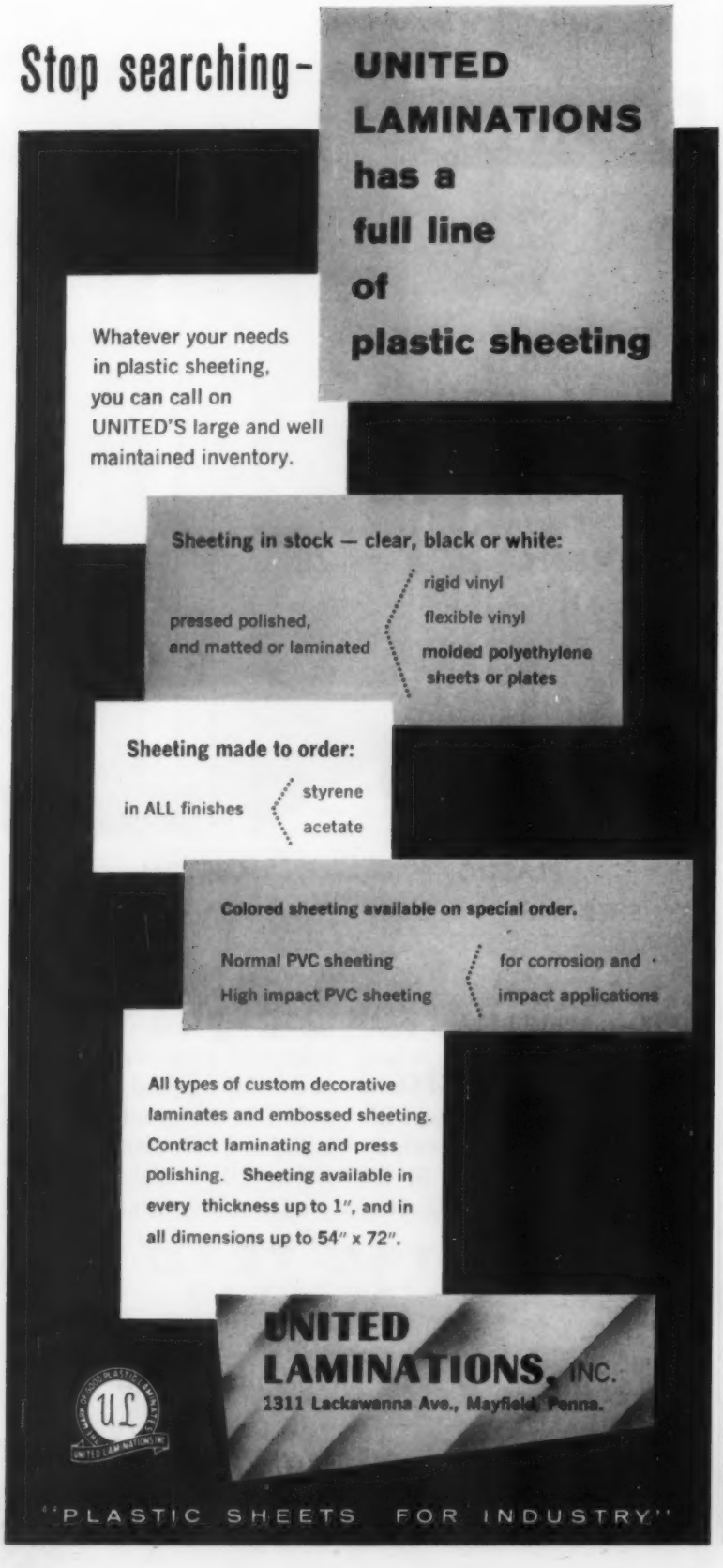
Portage engineers and designers will work with your sales and engineering staff in developing products from your own blueprints. Packaging and fabricating facilities are also available, PLUS plastic tubing from ⅛″ to ¾″ diameter.

For more information WRITE:

Portage Plastics Co., Inc.

MANUFACTURERS OF SHORECREST PLASTIC PRODUCTS

PORTAGE, WISCONSIN



gloss, semigloss, or dull finishes may be obtained. A series of solution-grade vinyl copolymers, acrylates, polymethyl methacrylates, butyrates, isocyanates, polyamides, and other resins are available to the film and sheeting converter for achieving the most desirable balance of properties such as controlled gloss, high flexibility, optimum wear resistance, cleanability, stain and perspiration resistance, lacquer marring, ultra-violet and chemical resistance, and antiblocking.

Clear protective vinyl or polyester (Mylar) films may be applied over decorated film and sheeting by lamination or by embossing-lamination techniques. The plastics industry is actively pursuing the development of a top coating that will increase abrasion resistance, prevent plasticizer migration, and expand the service life of vinyl film and sheeting.

References

Consult the Subject Index for additional information on processes and equipment for decorating plastics film and sheeting. For sources of materials and of equipment for decorating film and sheeting, see Directory Index, p. 1018.

"Casting plastics sheets," by J. O. Beattie, MODERN PLASTICS *33*, 109 (July 1956).

"Treating polyethylene in printing," by S. F. Bloyer, MODERN PLASTICS *32*, 105 (July 1955).

"Polishing plates for sheet plastics materials," Plastics (London) *21*, 281 (Oct. 1956).

"Painting and metallizing of plastics," by L. E. Parks, SPE J. *12*, 17 (Feb. 1956).

"Decorated molded plastics," by L. E. Parks, Plastics Tech. *1*, 620 (Nov. 1955).

"Surface treatment of moldings: Part I. Painting and lacquering," by M. Fuzzard, Brit. Plastics *28*, 413 (Oct.); "Part II. Hot-stamping, printing, and electrodeposition," ibid. 452 (Nov. 1955).

"Dry offset process for decorating molded plastics," by C. R. Johnson, Plastics Tech. *1*, 486 (Sept. 1955).

"Metallized plastic films," by T. Hammer, Product Eng. *26*, 182 (Aug. 1955).

Why Kodapak Sheet for window signs . . .



Signs printed on Kodapak Sheet by Goodren Products, Englewood, N. J.

The inside-outside story

WINDOW SIGNS printed in brilliant color on durable, clear-as-glass Kodapak Sheet are easy to see through—from inside or outside.

This means retailers can display them without hiding merchandise, without blocking the vistas of today's "open front" stores.

Little wonder retailers like them . . . use them . . . keep them doing their selling job.

Little wonder advertisers like them because *they do get used.*

And little wonder good sign-makers turn to Kodapak Sheet for this purpose. For Kodapak—uniform, stable, free from defects—provides an ideal surface for printing, keeps production costs at a minimum.

If you're interested in window signs or any of the hundreds of other uses for Kodapak Sheet, call our representative, or write.

Kodapak Sheet

"Kodapak" . . trademark for Eastman's plastic sheet

MAKES GOOD MERCHANDISE SELL BETTER

Cellulose Products Division, EASTMAN KODAK COMPANY, Rochester 4, N. Y.

Sales Offices: New York, Chicago, Atlanta. Sales Representatives: Cleveland, Philadelphia, Providence.
Distributors: San Francisco, Los Angeles, Portland, Seattle (Wilson & Geo. Meyer & Co.); Toronto, Montreal (Paper Sales, Ltd.).

STYRENE

Rubber-Modified Styrene Sheet

S-300 Styrene Sheet — A strong but lightweight sheet that can be made to take complex shapes by vacuum forming, or any conventional forming technique, with speed and economy on low cost dies.

S-540 Styrene Sheet — Is similar to S-300 but with exceptionally high impact resistance. Many applications in toys, displays, appliances.

Copolymer Styrene Sheet

S-1029 — An extruded styrene sheet with higher strength, greater color control. It has outstanding impact resistance *even at temperatures as low as —40F.* Copolymer also has high tensile and flexural strength, and a relatively high heat distortion point. Its chemical resistance is exceptional, particularly to acids and alkalis. Free from internal strain — it is readily vacuum-formed into complex shapes. Well suited to many applications such as machine housings, tote boxes, luggage, and photo trays.

All of these styrene sheets come in a wide variety of "built-in" colors. Finishes include mat, glossy, and new, simulated woodgrain. It's easy to paint, silk-screen or emboss.

CELLULOSICS

A-130 Cellulose Acetate — Noted for its strength and toughness. The sheet is excellent for vacuum forming. Ideal for blister packs. The film is used extensively in wraps.

B-120 Cellulose Butyrate — Has exceptional strength in thin sections . . . can endure long exposure. Applications in displays and outdoor signs.

E-100 Ethyl Cellulose — Highest thin-section toughness of all . . . maximum dimensional stability . . . minimum water absorption . . . light in weight.

new data on CAMPCO plastic sheet and film

POLYETHYLENE

Heavy Gauge Polyethylene Sheet — All conventional forming techniques can be used. Many housewares and packaging applications. We assist in experimental arrangements — various formulations, as your needs require.

Rigid Polyethylene Sheet — A brand new linear "low pressure" extruded polyethylene sheet, with excellent resistance to heat distortion — high rigidity and impact resistance, even in thin gauges. Highly inert — will withstand a wide variety of chemical attack, including some acids that even attack glass. Available in both Zeigler and Phillips types — in the same sizes and shapes as well-known S-300 and S-540 modified styrene. Excellent for many applications in both industrial and consumer products.

The range of CAMPCO applications is almost without limit. We would like to work with you in making the best use of these versatile materials. Write or phone today.

CAMPCO **DIVISION OF**
CHICAGO MOLDED PRODUCTS CORP.

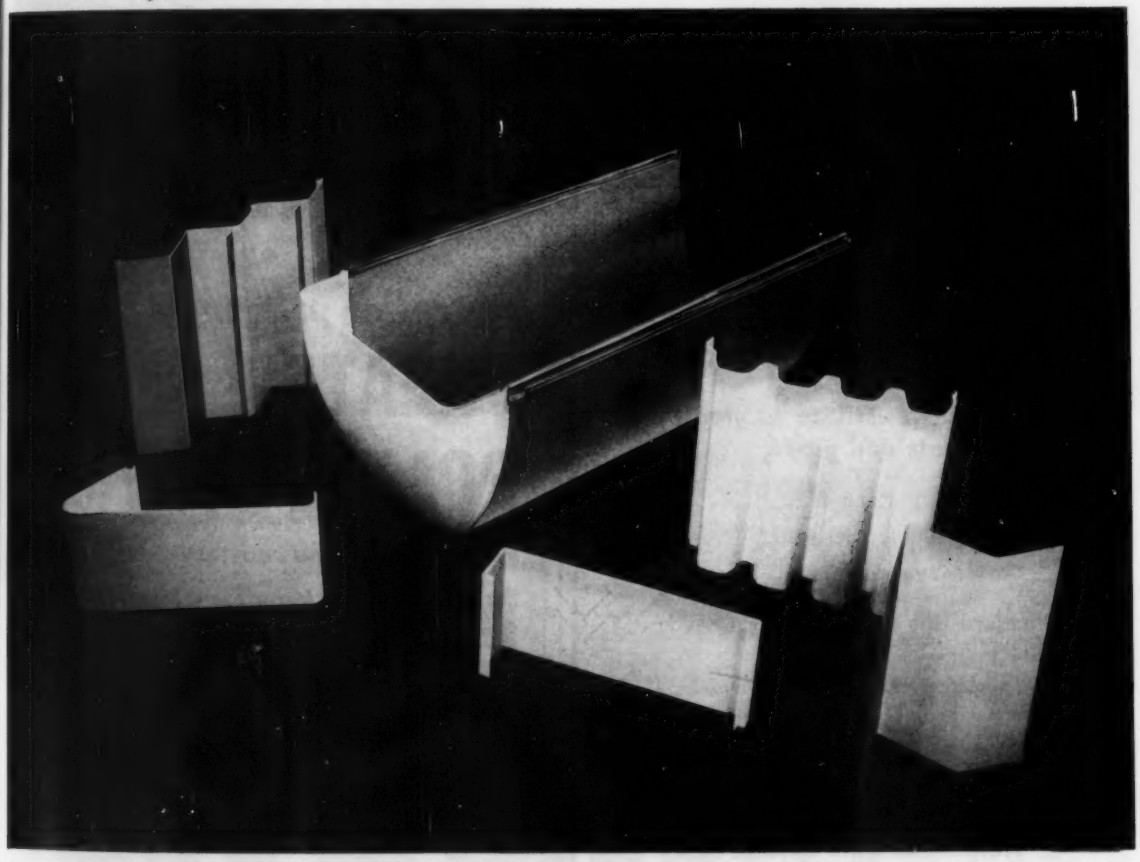
2709 Normandy Avenue
Chicago 35, Illinois

NOTE: See the Directory Section for particulars on Chicago Molded's unmatched custom molding services for plastics of all kinds.

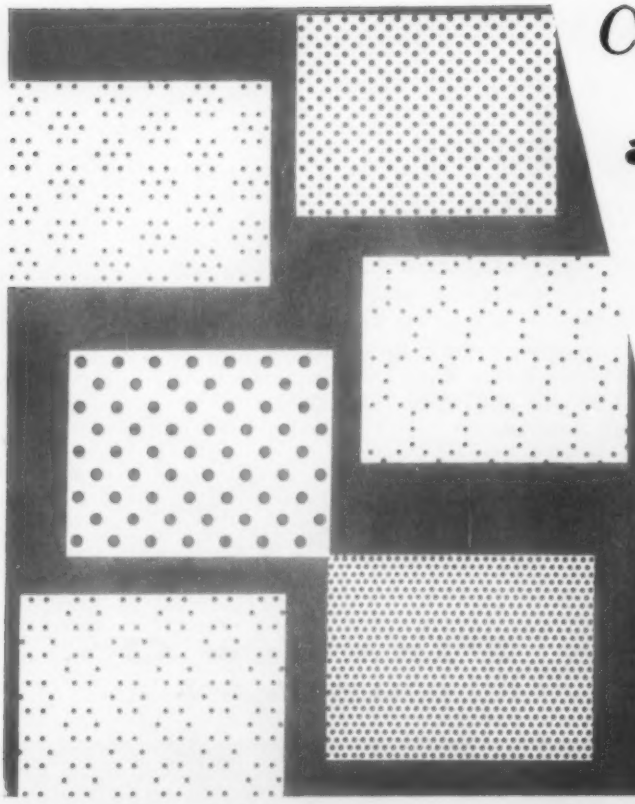
Imagineering In Industrial Plastics . . . .

When it comes to a perfect combination of imagination and engineering skills — SOPLASCO provides the necessary "Imagineering" to make any job a precision performance in plastics. A modern plant, a thorough knowledge in plastics, speed of production, and a location in one of the lowest overhead zones in the United States — are just a few of the important factors why you should choose SOUTHERN PLASTICS for your next job.

Southern Plastics Co.
408 PENDLETON ST. COLUMBIA, S.C.



Plastics Extrusions • Compression Molding • Precision Fabrication



Custom
Perforating and Slitting

—on all types of flexible materials, rigid sheets, and foam.

plastics
cellophane
paper
fabrics
rubber

in sheets and rolls up to 72" wide

Whatever your perforating needs, PERFORATING INDUSTRIES has the specialized equipment and know-how to handle the job. Rely on us if you're looking for quality workmanship, prompt delivery, and fair pricing.

For a quick quotation, write to us and include the width, gauge and quantity of material you want perforated—and at the same time, ask for your free copy of Catalog #57.

Perforating Industries, inc.
336-338 W. Westfield Avenue, Roselle Park, N. J.
Phone: Chestnut 1-0377

Polyvinyl Alcohol Film

Phenomenal resistance to greases, oils, many solvents and gases.

- Excellent parting film.
- Water Soluble packaging.

TYPES:

Standard-Hot Water Soluble (HWS)
Cold Water Soluble (CWS)

Thickness: 1 to 12 mils—width 54"

Mono-Sol Corp.
Gary, Ind.

PIONEERS IN BAND CASTING FILM

INKS

for roller printing on

TREATED POLYETHYLENE

vinyl • polystyrene • acetates • butyrates

For samples and technical information, call or write

ATLAS COATINGS CORPORATION

5-35 47th Ave., Long Island City 1, N. Y.
STillwell 4-0537

from nixon's

COMPLETE LINE OF FORMABLE SHEETING

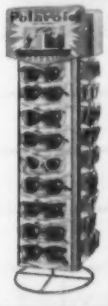
come all kinds of less costly, more interesting products



NIXON MODIFIED VINYL
for a luxury look. Rich brown alligator grain is meticulously reproduced in this attractive display case for men's jewelry. Nixon supplies all types of vinyl sheeting with exceptionally fine forming characteristics, up to 54″ wide, in gauges from .005 to .040. *Pressure formed and constructed by Plaxall Inc., Long Island City, N. Y.*



NIXON CELLULOSE ACETATE
creates a sparkling, sales-appealing gift package for quality power tools. Provides visibility as well as protection. The durable .020-gauge Nixon sheet was *vacuum formed by Klear-Form Pak, Inc., Baltimore 30, Md.*



NIXON HIGH-IMPACT STYRENE
for sturdy, lightweight rotary counter display and sales dispenser. *Designed and vacuum formed by Mechtronics Corp., Mamaroneck, N. Y.*

NIXON CELLULOSE ACETATE, BUTYRATE AND NITRATE SHEETING, in a striking variety of colors and patterns, were used for the sunglass frames, *manufactured by American Optical Co., Chelsea, Mass.*



NIXON CELLULOSE ACETATE BUTYRATE
stands up under rugged outdoor conditions and takes well to all kinds of processing. This Indian head of Nixon butyrate sheet was first metalized to an eye-arresting "gold," then vacuum formed. Mirro-Brite butyrate supplied by *Coating Products, Englewood, N. J. Vacuum formed by Chanal Plastics Corp., Brooklyn 6, N. Y.*



NIXON HEAVY-GAUGE VINYL
speeds production, cuts costs and facilitates handling of television's scenic effects. Over 13½′ long, 18″ in diameter, this column weighs only 15 lbs. Old style weighs 150 lbs. *Vacuum formed by National Broadcasting Company Inc., New York, N. Y.*

NIXON ALSO MANUFACTURES RODS IN A WIDE RANGE OF MATERIALS, COLORS, SIZES.

nixon PLASTICS

NIXON NITRATION WORKS • FOUNDED 1898 • NIXON, NEW JERSEY

Phone — New Brunswick, Charter 9-1121, Metuchen Liberty 9-0200, New York Extension WOrth 4-5290. **Chicago Office,** 510 North Dearborn Street, Phone Michigan 2-2363. **St. Louis, Mo.,** C. B. Judd, 3687 Market Street, Phone JEfferson 5-8082. **Leominster, Mass.,** A. F. Perry, C. A. Davidio, Phone 7-2120. Canadian Distributor: Crystal Glass & Plastics Ltd., 130 Queens Quay East, Toronto, Ontario.

Always a
dependable Source!

COMMERCIAL

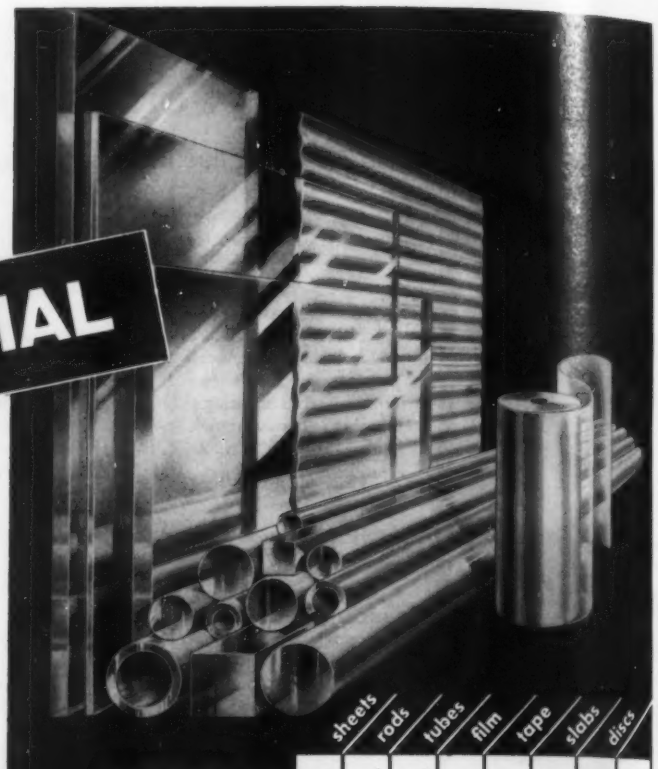
stocks in depth

PLASTIC SHEETS, RODS, TUBES, etc., *for* IMMEDIATE DELIVERY *from its* NEW YORK NEWARK PITTSBURGH *and* MIAMI *Warehouses!*



New* 64-page Catalog and Price Schedule *Yours...on Request!

Catalog lists complete specifications, dimensions, colors and prices of industrial and decorative plastic sheets, rods, tubes, etc. — either cast, extruded, molded or laminated. Plastic coatings and fabrication supplies are also included.



	sheets	rods	tubes	film	tape	slabs	discs
PLEXIGLAS	√	√	√				
NYLON	√	√	√	√	√	√	√
TEFLON	√	√	√	√	√	√	
VINYLITE	√	√	√				
ACETATE	√	√	√	√			
POLYSTYRENE	√	√	√			√	√
POLYETHYLENE	√	√	√	√		√	
PHENOLIC LAMINATES	√	√	√				

Commercial Plastics and Supply Corp.
630 Broadway, New York 12, N. Y.
Gentlemen:

Please send the following . . .

- ☐ 64-pg. Catalog & Price Schedule "Plastics for Industry"
- ☐ "Sq. Ft. Converter Chart" for sheets up to 67" x 102"
- ☐ "Plastics Properties Chart"

Name_____

Address_____

Company_____



PHONE:
GRamercy 7-5000

COMMERCIAL PLASTICS AND SUPPLY CORP.
630 BROADWAY, NEW YORK 12, N. Y.

Branch Warehouses: **Newark, N. J., 170 Malverne St. • Pittsburgh, Pa., 119-9th St. • Miami, Fla., 3801 N.W. 2nd Ave.**

Joseph Davis Plastics



ACETATE
Hi-impact Styrene
SHEETS
FILM
Rods and Tubes

Cellulose Acetate..Butyrate..Hi-impact Styrene
Transparent, translucent, opaque..
light-to-heavy gauges..cut and slit-to-size **suitable** for

VACUUM FORMING



JODA crystal-clear cellulose-acetate, butyrate and rigid polyethylene sheets and film ideally and economically suited for

BLISTER AND SKIN PACKAGING

For further information and samples, please contact

JOSEPH DAVIS PLASTICS COMPANY

Phone KEarny 2-0980-0981 JODA N. Y. BArclay 7-6421-2

430 Schuyler Ave., Arlington, N. J.

Sales Representatives Conveniently Located



tough, versatile

U.S. Royalite *the sheet fabricating material that turns designers' dreams into practical realities*

Is the case, cabinet, cover or other part of your product now made of a material which leaves something to be desired in . . .

Economy? Royalite® assures exact, inexpensive prototypes . . . lower tooling, finishing and assembly cost . . . fewer operations.

Beauty? Royalite molds readily to shape, detail and contour . . . retaining its eye-catching, sales-appealing color and texture.

Durability? Patented compounding of thermoplastic fortified with rubber gives never-before wearability. It's super-tough to resist impact . . . yet weighs less than any metal. Custom formulized to meet specific needs such as oil and chemical resistance, moisture-resistance, and performance at extremes in temperature.

There is a Royalite sales engineer in your area. If you would like to have this specialist call on you, please write United States Rubber Company, Royalite Division, 2638 North Pulaski Road, Chicago 39.

United States Rubber

2638 N. Pulaski Road, Chicago 39, Illinois

Industry's Largest PRESS-LAMINATED SHEETS

Standard sheet size 48″ x 96″—gauges from .050″ to 2.0″—Seilon CR . . . HI . . . LC . . . FHI . . . S-3 . . . DP.

CALENDERED SHEETS

Widths to 54″, calendered rolls or sheets cut to size. Seilon CR . . . HI . . . LC . . . FHI . . . S-2 . . . S-3.

EXTRUDED SHEETS

Widths to 48″, gauges from .020″ to .250″, extruded rolls or sheets cut to size. Seilon S-1 . . . S-3 . . . ETH.

SEILON!

SEILON is the Seiberling trade-name for a quality family of rigid thermoplastic sheets. You will find that SEILON is easy to form, easy to work, and can be welded with ease. We will be glad to send you complete information.

Seiberling Plastic Division is adaptable to customers' requests—and we will welcome the opportunity to consult with you on individual specifications of properties, gauges, colors and finishes for your products.

SEILON DESCRIPTIONS AND APPLICATIONS:

CR—Type I P.V.C. corrosion.

HI—Type II P.V.C. corrosion.

LC—Copolymer vinyl sheets for printing, laminating and vacuum forming.

FHI—High-impact copolymer vinyl sheets for printing, laminating and vacuum forming.

S-1—High impact polystyrene.

S-2—Super-high-impact polystyrene.

S-3—Tough thermoplastic material for vacuum forming.

DP—Corrugated or flat, polished or embossed, clear or opaque P.V.C. sheets for glazing and decorative applications.

ETH—Extruded polyethylene for vacuum forming, also for fabrication of corrosion-resisting equipment.



Plastics Division **SEIBERLING RUBBER COMPANY**

NEWCOMERSTOWN, OHIO • PHONE 8-8304

PLASTIC SHEET FOR THE VACUUM FORMING INDUSTRY

GILMAN NOW OFFERS

Stylour* — PLASTIC SHEET FLOCKED BEFORE FORMING

STYLOUR* is an amazingly versatile new material with almost unlimited application possibilities. Made of a special formulation, super high-impact styrene sheet, STYLOUR* is coated with a cotton or rayon flock which retains velvety-finish after forming. Available in a variety of brilliant colors and a wide range of thicknesses, lengths, widths and plastic finish combinations.

PLUS

GILCO **RIGID POLYSTYRENE PLASTIC SHEETS**

Extruded From Dow Styron®—Ideal For Vacuum Forming

All colors—all lengths

Widths to 52 inches

Gauges .010 to .250

Super High-Impact in either polished or matte finish. Specialized Translucent Formulation for lighting use. High-impact in polished or high-luster finish.

PLUS

GILCO **DECORATIVE SHEET**

First polystyrene decorated sheet. Available in numerous handsome finishes and colors of your choice. *Gilco Pelican Sheet* also in a scratch resistant finish that retains its original grain after forming.

PLUS

GILCO **POLYETHYLENE SHEET**

From .010 to .250 gauge in various formulations—low density, medium density and high density. In sheets or rolls up to 52" wide.

Whatever your needs . . . if it calls for plastic sheet call

THE GILMAN BROTHERS COMPANY

ESTABLISHED 1897 • GILMAN, CONNECTICUT

*Trade Mark

Manufacturers of Stylour* • Gilco Rigid Plastic Sheets • Gilco Tie Pads • Cellulite Insulation and Celluliner Cushioning Material

Prompt at your SERVICE

We carry the following plastic in stock—for all your immediate needs!



PLEXIGLAS
Standard Type II UVA
Also Type "R"—the lower priced
Acrylic sheet
Masked and Unmasked

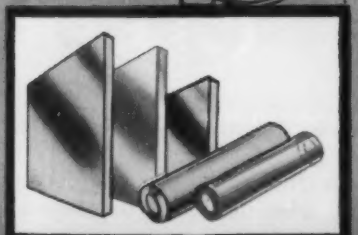
VINYLITE
Rigid and Flexible
Clear—Colors—Calendered—Matte

CELLULOSE ACETATE
Clear—Colored—Matte—Extruded

ACETATE BUTYRATE
Polished—Extruded

POLYSTYRENE
Natural—Colored

POLYETHYLENE
.015 thru .125 thicknesses
Large Sheets



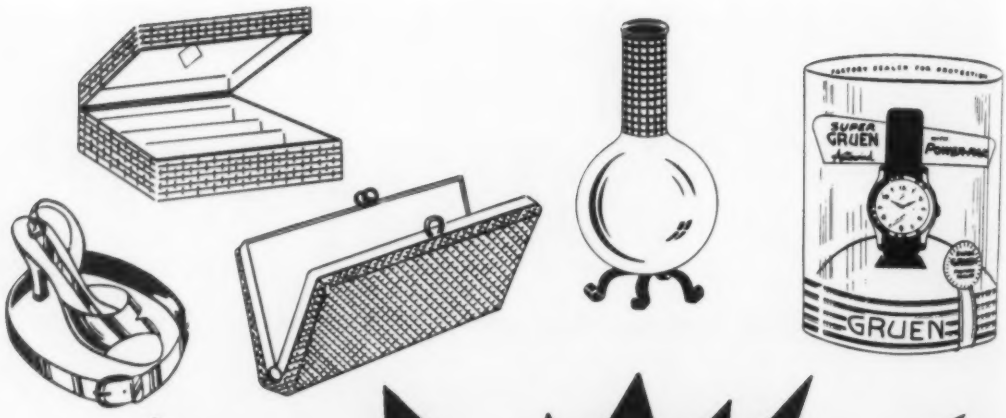
TRANSILWRAP COMPANY

Write for Informative Free Booklets

2814 WEST FULLERTON AVE. · Dickens 2-2616 · CHICAGO 47, ILLINOIS

EASTERN DIVISION: 1647-49 HENVIS • Davenport 9-2241 • PHILADELPHIA 40, PA.

SOUTHWEST DIVISION: 4430 FOREST LANE • Taylor 6-4405 • GARLAND (DALLAS), TEXAS



Famous Name Manufacturers Dazzle the Market
with Products Dressed in

MIRRO-BRITE

metallized and laminated

"MYLAR"*



Every day, new products by major manufacturers are added to the growing list of "best sellers" dressed in beautiful, versatile MIRRO-BRITE "MYLAR."
"Mylar's" attractive eye-and-buy appeal effectively brightens the sales picture for such a wide variety of products . . . refrigerators, stoves, radios, television sets; point-of-sale signs and three dimensional displays; automotive panels; women's accessories and shoes as well as other usages. Send for illustrated sampler, color chart and price list.

"Mylar"* is DuPont's registered trade mark for its brand of polyester film.

COATING PRODUCTS

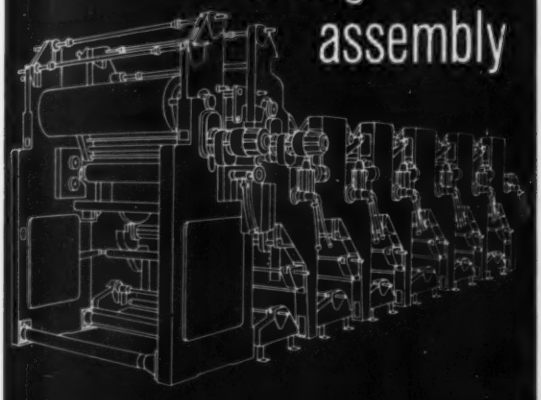
101 WEST FOREST AVENUE, ENGLEWOOD, NEW JERSEY

DORNBUSCH

presents the incomparable

new **ROTODORN**

surface welding assembly



Not an embosser with limited laminating potential

BUT

— a radically new surface welder to produce film laminates up to .156 inches thick (with or without a fabric interply)

PLUS

— embossing and valley printing at the same time.

Contact us for complete data and samples

RINGLER-DORIN, INC

315 FIFTH AVENUE • NEW YORK 16, N.Y.

MUrray Hill 3-9588

LARCRYLIC

The quality acrylic sheet by

Larc products inc.

Larcrylic sheets come in varied sizes and thicknesses. There is a standard size available for your needs—from 48″ x 48″ to 100″ x 120″. Thicknesses from .06″ to .375″. In crystal clears or whites.

And Larcrylic is the ideal material for economical fabrication. Easy to form, saw, drill and cement.

Reliable Service . . . You won't need to carry big inventories as orders can be processed very quickly with our new high speed equipment. A railroad siding runs right to our plant; trucks are standing by; even planes if you prefer.

Customers will like the packaging which is designed with the problems of material handling in your shop in mind.

Protected distributorships available in some locations.

Larc products inc.

BOX 327, AMSTERDAM, NEW YORK

Larcrylic—we're proud to put our label on it.



"Our greatest challenge . . . the development of men"

Ralph Cordiner, President, General Electric Company

"Few expenditures we can make are more important than those for education. A well-educated person produces more and consumes more, makes wiser decisions at the polls, mounts a stronger defense against aggression, and is better able to perform the grave responsibilities of American citizenship.

"Freedom needs educated people. So do business and industry. I earnestly ask you to support the college or university of your choice in its planning for expansion and a stronger faculty. The returns will be greater than you think."

PUBLIC SERVICE ADVERTISING COUNCIL

If you want more information on the problems faced by higher education, write to: Council For Financial Aid To Education, Inc., 6 E. 45th Street, New York 17, New York

HIGHER EDUCATION KEEP IT BRIGHT

Sponsored as a public service, in cooperation with the Council for Financial Aid to Education

Advertisers' Index

FILLERS AND REINFORCEMENTS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 468.

ASBESTOS FILLERS

Powhatan Mining Company 494

CELLULOSE FILLERS

Brown Company 484

COTTON FILLERS

Claremont Waste Manufacturing Co. 489
Plymouth Fibres Co., Inc. 486
Rayon Processing Co. of R. I. 502

MINERAL FILLERS

Diamond Alkali Company 490
English Mica Co., The 500
Hayden Mica Company 504
Minerals & Chemicals Corp. of America 496

MOLD RELEASE

Polyplastex United, Inc. 502

PIGMENTS & COLORANTS

Ciba Company Inc. 491-492

PRE-IMPREGNATED MATERIALS

Coast Manufacturing & Supply Company 488
Cordo Molding Products Inc. 483
Electro-Technical Products, Div. of Sun Chemical Corp. .. 501
Polyplastex United, Inc. 502
Sandman, Eli, Co. 501
Standard Insulation Company 500

PROCESSORS OF REINFORCED PLASTICS

Brunswick-Balke-Collender Company, The 499
Sandman, Eli, Co. 501

REINFORCING MATERIAL

Coast Manufacturing & Supply Company 488
Ferro Corporation, Fiber Glass Div. 497-498
Flightex Fabrics, Inc. 504
Modiglass Fibers, Inc. 504
Pittsburgh Plate Glass Co., Fiber Glass Div. 495
Troy Blanket Mills 503
Wellington Sears Co. 493

SPECIALTY PAPERS

Mosinee Paper Mills Company 485

SURFACE COATINGS

Rayon Processing Co. of R. I. 502

Fillers for Molding Compounds

BY RAYMOND B. SEYMOUR*

Fillers vary widely in composition, physical form, and cost. Their utility is determined almost entirely by the physical, chemical, and electrical properties of the product obtained by molding the mixture consisting of resin, filler, and other essential ingredients.

Impact values

Since fillers reduce brittleness (increase resistance to impact), phenolic molding compounds are often classified in accordance with the relative impact strengths of the molded products. Unfortunately, the impact values are usually based on the brittleness of notched specimens, even though the elimination of notches is a basic requirement for good plastics design.

In the absence of related end-use knowledge and experience, the published impact data are of limited value in the selection of specific types of molding compounds. At best, these values are relative. Hence, attempts to compare them often lead to erroneous conclusions.

As might be anticipated, a specimen molded from an A.S.T.M. Type 6 phenolic molding powder, having an impact value of 4.0, is less brittle than one molded from Type 2, which has a value of 0.24. It is erroneous, however, to state that Type 6 has an impact resistance 16 times greater than Type 2.

Impact values are very useful in checking quality and consistency within a general class of molding compositions. But it is incorrect to assume that different molding compounds with similar impact resistance values will exhibit comparable resistance to physical damage under actual conditions of use.

Obviously, other properties must also be compared in the selection of suitable molding compounds. When impact values are similar, it is essential that values for modulus of elasticity, flexural strength, and tensile strength be compared.

Types of fillers

As might be anticipated, many of the commercially used fillers are fibrous in nature. They may be naturally occurring minerals, such as asbestos, or organic materials, such as wood flour or cotton flock.

The organic fillers are sometimes classified as cellulose derivatives, lignin, protein, and carbon. These may be subdivided as shown in Table I, p. 470. Inorganic or mineral fillers are usually described generically.

Wood flour: Most of the wood flour used as fillers for molding compounds is obtained by attrition-type grinding of soft woods, such as Douglas fir, Norway fir, ponderosa pine, sugar pine, spruce, poplar, basswood, and cottonwood. The specific gravity of most soft wood flour when compressed is approximately 1.4. When equal parts of wood flour and resin are used, the specific gravity of the molded part will be approximately 1.35. Contamination from knots, bark, and resin spots must be kept at a minimum. Moisture should also be kept below 8% and preferably not over 5 percent.

Shell flour: When walnut shell flour is used in place of wood

* President, Loven Chemical of California, 244 S. Pine St., Newhall, Calif.

The assistance of the following who aided in the preparation of this article is greatly appreciated: J. Baum, W. P. Bennett, and A. A. Vacca, Loven Chemical of Calif.; R. T. Brotz, Plastics Engineering Co.; R. G. Booty, Booty Resineers, Inc.; R. W. Forbes, Barrett Div., Allied Chemical & Dye Corp.; A. W. Hanmer, Jr., Durez Plastics Div., Hooker Electrochemical Co.; W. H. Meadowcroft, Weyerhaeuser Timber Co.

Recent Developments and References were prepared by the editors.

flour molded parts with slightly lower resistance to impact and higher moisture resistance are obtained. Shell flour, as well as residues from furfural manufacture, may be used as an extender for resin glues, but there is no known significant use of these products at present in phenolic molding compounds.

Cotton flock: Cotton flock is used for the production of medium-impact molding powders. Such products exhibit slightly less shrinkage during molding than wood-flour-filled materials, but are more expensive and less readily molded.

Macerated fabric: Molding compositions containing chopped fabric have outstanding resistance to impact. These products are extremely bulky and are difficult to preform and mold. They are finding considerable use, however, when other products with normal impact resistance are not satisfactory.

Lignin fillers: According to the principal producer of ground fir bark, substantial quantities of this product are used by Eastern molding compound manufacturers. This product is also used extensively in the West as an extender for phenolic resin glues used in the manufacture of plywood.

It has been claimed that the flow characteristics of bark flour products make exceptionally high loadings possible. The producers of fillers derived from Douglas fir bark claim economies as a result of a decrease in resin content of the resulting molding powder.

These claims have been substantiated by experiments conducted in molding compound producers' laboratories. One of the leading producers of phenolic molding compounds for deep draw molding, however, has not been able to substantiate these laboratory results in actual production; this company found that the surface of the last third of the molded article was unsatisfactory whenever deep draws of 20 to 22 in. were attempted using phenolic molding compounds containing bark fillers.

Asbestos: The bulk of asbestos products used as fillers in phenolics molding compositions are classified as "floats." Molded asbestos-filled products have a high specific gravity and possess excellent resistance to heat and chemicals.

RECENT DEVELOPMENTS

A synthetic mica (*Synthamica 202,* Mycalex Corp. of America) is chemically pure, crystal clear, and comes in chunk, flake, and ground powder; it is a synthetic fluor-phlogopite and a true crystallographic analog of natural phlogopite mica. The principal difference between synthetic mica and natural mica, aside from its chemical purity and absence of discoloration, is the fact that the hydroxyl that is present in natural mica is replaced with fluorine, eliminating all possibility of the synthetic mica bloating or outgassing at elevated temperatures in a vacuum where trouble is experienced with the natural micas. The high thermal endurance of 202 makes it a very desirable material for high-temperature applications. It can be used as a high-temperature potting compound with a phosphoric acid treatment and subsequent high-temperature after-bake. The 202 product is also combined with glasses and ceramic binders to produce high-temperature ceramoplastic molding compounds sold under the trademark of Supramica.

A line of walnut shell flours, grits, and abrasives (*Stan-Shell,* Harwick Standard Chemical Co.) is available in a variety of mesh sizes. Fine nutshell flours are suggested for use as fillers for plastics and rubber and as extenders and fillers for phenolic resins. The coarser materials are used in air blast cleaning of molds and other products.

Manufacturing methods

Methods of manufacturing each of these fillers are as follows:

Wood flour is produced by a process that may be described as defibering rather than by cutting. Providing the size reduction is not too great, this attrition-type grinding preserves some of the original fiber structure. The typical fiber in 100 mesh wood flour is 0.004 in. long and has a cross-section of 0.00004 inch.

Shell flour is obtained by grinding various shells, such as walnut, pecan, or peanut shells. The product is somewhat spherical, rather than fibrous in form. Thus, the molded parts obtained have a smoother finish, but lower resistance to impact than those containing fibrous-type fillers.

Cotton flock is usually obtained by processing cotton clippings. A product with shorter fiber length is prepared by the caustic purification of cotton linters.

Alpha-cellulose is produced by an alkaline treatment of bleached wood pulp. Because of its pure white color and low density, it is used widely as a filler in urea and melamine molding powders.

Sisal fiber is generally used as a mat which is impregnated with a liquid phenolic resin. Prior to impregnation, the strength of the mat is usually improved by a needling process which drives tufts of fiber through the mass.

Chopped paper is usually impregnated with resin before being cut into fragments. Diced resin board is produced from sheet stock made from a suspension of pulp and resin.

Macerated fabric is produced by cutting various types of clean cotton cloth into small pieces.

Lignin fillers may be produced from the bark of trees such as Douglas fir or by extending wood flour with derivatives of lignosulfonic acid. Since lignin is the natural binder for cellulose in wood, the use of such products as partial replacement for resins in molding powders is possible.

Soybean meal is prepared by grinding the bean residue after the extraction of oil. When soybean meal is used as a partial replacement for wood flour, the molded parts exhibit poor resistance to moisture.

Keratin products, such as

TABLE I: Types of fillers

Organic fillers

A) Cellulose derivatives
  1) Ground flours
    a) Soft wood flours (e.g., pine)
    b) Hard wood flours (e.g., maple)
    c) Shell flour (e.g., walnut shell)
    d) Natural by-products (e.g., cotton seed hulls)
  2) Cellulosic fibers
    a) Cotton flock
    b) Alpha-cellulose
    c) Sisal fiber
  3) Cemminuted cellulose
    a) Chopped paper
    b) Diced resin board
    c) Creped paper
    d) Pulp preforms
    e) Textile by-products (e.g., macerated fabric)
B) Lignin and lignin-extended fillers (including ground bark)
C) Protein fillers
  1) Protein meal (e.g., soybean meal)
  2) Keratin (e.g., ground feathers)
D) Nylon filler
E) Carbon fillers
  1) Graphite
  2) Carbon black

Inorganic (mineral) fillers

A) Asbestos
B) Mica
C) Diatomaceous earth
D) Chalk
E) Glass fibers
F) Miscellaneous: barium sulfate, litharge, clay, chalk, etc.

feathers, hoofs, or hog bristles, are usually calcined before use. These products, like lignin, permit a reduction in the amount of resin used in the molding powder.

Nylon, when used as a filler, produces a strong product which shrinks considerably during molding.

Naturally occurring *graphite* may be added to molding compounds in order to produce self-lubricating bearings.

Carbon black exhibits little reinforcing action in phenolic resins and actually contributes toward brittleness.

As would be expected, graphite and carbon blacks produce dark molded parts. Carbon black is used sometimes in small quantities as a pigment. The use of acetylene black yields molding powders with good electrical conductance.

Asbestos is a naturally occurring fibrous material obtained by cleavage of the mineral chrysotile—a form of hydrated magnesium silicate. Asbestos improves the heat resistance of molding powders, but increases the specific gravity.

Mica is obtained from the mineral muscovite, a complex potassium aluminum silicate. This filler is not readily wetted by the resin, but yields a molding composition which possesses excellent electrical properties and good resistance to heat.

Diatomaceous silica is an amorphous fossil consisting of the remains of diatoms. It has a lower specific gravity than asbestos or mica, but is not quite as effective as these fillers in improving heat resistance and electrical properties.

Glass fibers are produced by the extrusion of molten glass through tiny orifices. Molding compounds containing long-fibered glass have excellent resistance to impact and heat.

The inorganic compounds, such as *litharge, barium sulfate,* and *chalk,* are seldom used without other fillers. They contribute special properties such as high density and X-ray opacity.

Compounding techniques

Whenever the filler is available as a readily wettable powder it is generally mixed intimately in a ribbon blender with approximately an equal weight of phenolic resin previously compounded with other ingredients. When a two-stage resin is used, hexamethylenetetramine is also added as a curing agent.

The other ingredients, such as mold lubricants, dyes, pigments, and other finely divided powders, are usually present in small proportions.

The completely mixed formulation is usually passed between steam-heated rolls in order to secure a more intimate mixture and advance the resin. The compounded sheet is removed, cooled, and ground. The ground powder is then passed through sifting screens to remove the fines and tailings.

The portion with the desired screen analysis is then conveyed to a blender in order to secure large quantities of uniform products.

Some fillers such as coarse fibers and fabrics cannot be processed by conventional methods, since the shearing action would destroy the desired fibrous structure. Fillers of this type are usually impregnated with a solution of resin, diced, and then chopped into small particles.

The requirements for an ideal filler are as follows: 1) Yield strong molded parts with good impact resistance. 2) Inexpensive and readily available in uniform quality. 3) Low specific gravity in molded parts. 4) Low moisture absorption. 5) No deleterious effects on workmen or molds. 6) Readily wetted and require a minimum amount of resin. 7) Light color not affected by molding temperatures. 8) Odor-free and chemically inert. 9) Non-flammable. 10) Good thermal and electrical properties.

Properties of fillers

A critical examination of all known commercially used fillers will show that none is satisfactory

on all counts. However, wood flour meets many of the requirements and hence is the most widely used filler in phenolic molding compounds. Since color is considered more important than cost, alpha-cellulose is the principal filler used in light-colored urea and melamine molding compounds.

An examination of the empirical values assigned for various fillers in Table II, below, will give some idea of their general usefulness. Since the ideal filler would have a rating of 10 for all properties listed, its total index value would be 90.

Under the above specifications for an ideal filler, impact resistance is listed ahead of cost. However, there are some instances where resistance to heat is considered more important than either strength or cost. In such instances, the danger of drawing erroneous conclusions can be minimized by placing proper emphasis on those properties considered critical for specific applications. Each index value must be weighed in accordance with its relative importance for each end use.

With the addition of various fillers, properties can change radically. An unfilled phenolic, for example, has an impact resistance (ASTM D 256) of 0.25 ft.-lb./in. of notch, while a general-purpose phenolic (wood flour filled) has 0.30 and a high-impact phenolic (macerated textile filled), 2.0. Values for other materials are listed in the Plastics Properties Chart.

Typical applications

Molded products made from general-purpose phenolic molding compounds with wood flour filler include handles for appliances and cooking utensils, telephones, radio cabinets, house wiring devices, and automotive equipment, where moderate heat and electrical resistance is required.

Alpha-cellulose is used as a filler in most light-colored urea and melamine molding compounds. The molded products include appliance handles, switch plates, and tableware.

Medium-impact molding compounds containing cotton flock are molded to form washing machine agitators, hair dryer parts, and small industrial wheels.

High-impact molding compounds reinforced with macerated cotton fabric are used to produce heavy-duty industrial parts, such as pulleys and terminal blocks.

Appliance handles, heater plugs, radio condensers, tube bases, and similar articles requiring good resistance to heat and moisture are frequently molded from compounds filled with mica or asbestos.

Because of their exceptional versatility, thermosetting resins compounded with appropriate fillers have been used for the fabrication of thousands of different molded articles. These compounds lack the glamour of some of the newer materials and, like all good "work horses," are sometimes overlooked until no other satisfactory material is found. When "rediscovered," these time-tested plastics fill a real need.

References

Consult the Subject Index for additional information concerning fillers for molding compounds. Consult the "Bibliography of Books and Magazines," p. 615, for general texts which have chapters on fillers. For sources of fillers, see Directory Index, p. 1018.

"Fibers help phenolics, melamines, and silicones to move into bigger fields," MODERN PLASTICS *34*, 155 (Oct. 1956).

"What's new in reinforcements," MODERN PLASTICS *33*, 81 (Feb. 1956).

"Surfactant-treated minerals as reinforcing fillers," by A. S. Michaels, Industrial Engineering Chemistry *48*, 297 (Feb. 1956).

"Fillers and reinforcements for molded plastics," by G. Lubin, Product Eng. *26*, 178 (Dec. 1955).

"Plastics aid residual products conversion," by T. A. Dickinson, Plastics (London) *20*, 414 (Dec. 1955).

TABLE II: Comparative properties of molding compounds with various fillers[1]

Filler	*Impact resistance*	*Cost*	*Specific gravity*	*Moisture resistance*	*Mold shrinkage*	*Moldability*	*Color*	*Chemical resistance*	*Resistance to heat*	*Total*
100-mesh pine	5	9	9	6	7	10	9	5	6	66
80-mesh fir	6	9	9	6	7	10	8	5	6	66
100-mesh walnut shell	4	9	9	7	6	10	7	5	6	63
Cotton flock	7	3	9	5	8	8	8	4	6	58
Alpha-cellulose	6	4	9	4	8	10	10	4	6	61
Macerated fabric	8	2	9	5	8	6	6	4	6	54
Fir bark	5	10	9	6	7	10	7	5	6	65
Soybean meal	3	10	9	3	6	7	7	3	5	53
Nylon	7	1	10	6	1	6	8	4	6	49
Carbon black	1	5	5	9	8	6	1	7	7	49
Asbestos floats	6	8	4	9	9	8	7	7	8	66
Mica	3	6	4	10	9	4	9	7	7	59
Diatomaceous earth	3	6	5	9	9	5	9	7	7	60
Chalk	3	10	4	9	9	3	10	7	8	63
Glass fiber	10	1	4	9	9	4	6	7	9	59
No filler	2	5	10	3	3	2	5	7	5	48

[1] Index values from 1 to 10 have been assigned, with 10 being most desirable. Values have been given equal weights in arriving at totals.

Fibrous Glass Reinforcements

BY C. E. HOOVER* and RALPH SONNEBORN*

RECENT DEVELOPMENTS

In recent research for the Air Force (Owens-Corning Fiberglas Corp. for Wright Air Development Center), a 50% increase in modulus of elasticity of fibrous glass was achieved by the continuous formation of fibers of a calcium aluminate glass in a small textile glass bushing. Resistance of these glasses to chemical attack by water and water vapor is much less than that of commercially produced textile fibrous glass. The glasses are resistant to hydrofluoric acid but are completely soluble in hydrochloric acid. Their dielectric constants are higher than that of present textile glass, and the loss tangents are about the same as compared with textile glass.

All-glass "paper" (*Micro-Fiber paper*, Textile Div. of L.O.F. Glass Fibers Co.,) used as a surface material for reinforced plastics gives a more durable and smoother finish. The reinforced plastics have a high degree of resistance to erosion because the extremely fine fibers in the paper hold down the coarser fibers underneath.

Another glass fiber paper (*Dexstar*, C. H. Dexter & Sons, Inc.), made on a conventional paper machine, receives fine quality printing on its surface with no tendency of the ink which is used to bleed.

Flame-resistant epoxy resin-impregnated glass cloth (*Stanpreg*, Standard Insulation Co.), engineered primarily for critical electrical and electronic applications, is used in laminates with 83,000,000 megohm-cm. volume resistivity, 25,000,000 megohms surface resistance, and 18,000,000 megohms insulation resistance. The cloth is furnished in dry, nontacky tapes or rolls, and has uniform resin content, consistent optimum flow characteristics, and extended shelf life.

A new reinforcing material (*Lamimat*, Bigelow Fiber Glass Products) allows molders and laminators of reinforced plastics to achieve high flexural modulus at low cost with light weight. This drapable, uniform, lightweight mat with a blended organic-glass core and an all-glass face can be used to make thicker sections with high flexural modulus and considerably less weight than when using mats of all-glass fibers.

Glass is used in a wide variety of forms as a reinforcement for plastics. The availability of many types of reinforcement makes possible great design latitude in strength, rigidity, cost, production methods, shape, size, and directional characteristics.

The basic fibers are, in general, the same for all the various forms—mats, rovings, yarns, or woven goods. These basic fibers are formed from a lime-alumina-borosilicate glass that is relatively soda-free; it is commonly referred to as "E" glass. The individual fibers (filaments) are made in several diameters from 0.00020 to 0.00100 inch.

Fibers have many of the characteristics of bulk glass, but some properties are severely modified. Mechanical strengths are increased and the chemical resistance is reduced.

The tensile strength of glass fibers is about 400,000 p.s.i.; this value is independent of the filament diameter. The modulus of elasticity (E) is close to that of bulk glass—10,500,000 p.s.i. The modulus of resilience (the energy absorption characteristic) is increased a thousandfold by the fibrous form.

Fiber surface

The key to an understanding of the properties and processing methods regarding fibrous glass is held in the fiber surface. Glass is an inert material, but because of the extremely great ratio of surface area to volume (1 lb. of roving has about 880 sq. ft. of surface), a proportionally small amount of chemical attack is magnified into a significant quantity. Therefore, a really clean surface is almost a hypothetical condition.

A virgin fiber, at the moment of formation, is uncontaminated. However, within a few seconds, it has been superficially attacked by moisture from the air. When the glass is under load, this phenomenon can cause what appears to be fatigue. However, fibers of glass show neither creep nor hysteresis at room temperature.

Glass does not bond well with plastics materials. Consequently, the surface must be prepared for acceptance of a resin in much the same manner that some metals must be primed before being painted. Glass surface treatments are discussed later in this chapter.

Manufacture of basic fiber

There are three basically different processes for manufacturing glass fibers: 1) steam or air blowing, 2) flame blowing, and 3) mechanical pulling. Most fibers used for the reinforcement of plastics are made by mechanical pulling. The two blown-fiber methods are used primarily for

* Owens-Corning Fiberglas Corp., 598 Madison Ave., New York, N. Y.

Recent Developments and References were prepared by the editors.

the manufacture of air filters, insulating materials, and staple yarns.

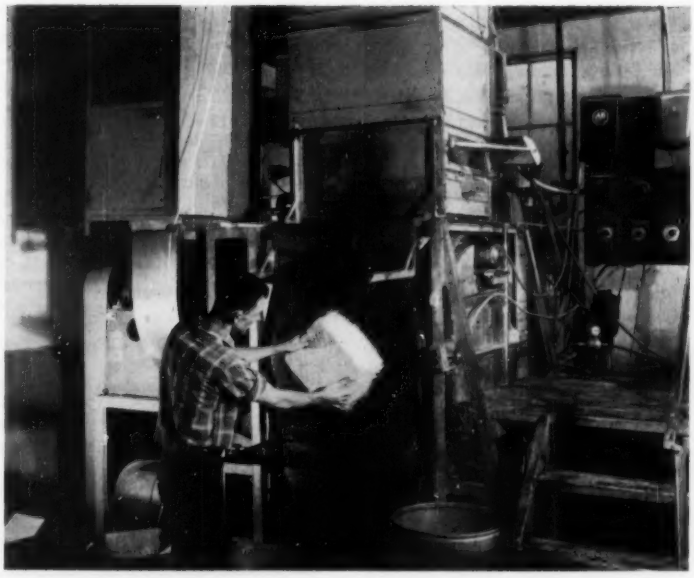
All these processes depend upon a small electric furnace with a number of metering orifices in the bottom. Molten glass flows through these orifices and fibers are attenuated from this molten stream. The bottom of the furnace which contains the orifices is known as a bushing. The design of bushings is very critical; because of the high temperatures involved, they often contain substantial amounts of the "noble metals."

Two methods are used to feed raw glass into the bushing: direct batch feed and marble feed. Direct batch feed consists of mixing the glass ingredients and melting them in a large gas-fired furnace. The molten glass then flows to the fore hearth where it is brought up to the proper temperature and is metered into the bushing. Where a marble feed is used, the molten glass is rolled into small marbles which can be shipped to the fiber-forming plant. These marbles are fed into the bushing on small tracks.

In the blowing processes, a jet of air, steam, or hot gas is directed at the molten stream. Short staple fibers are attenuated and become cool. Where extremely fine filaments are desired, a relatively thick "primary fiber" is mechanically pulled from the bushing and is in turn remelted and blown by a jet of extremely hot gas.

The mechanical pulling method produces a continuous fiber by mechanically drawing a filament from the stream of molten glass. During the early stages of cooling, the stream is attenuated into filaments by being pulled at very high speeds, normally in the range of 5,000 to 10,000 ft./minute. Depending upon the pulling speed, the orifice size, the molten glass temperature, and other variables, the filaments have a diameter from 0.00020 to 0.00075 inch.

For efficient production a number of filaments are formed simultaneously, one from each orifice in the bushing. These filaments are collected into a bundle known as a "strand" at a gathering device where a surface-treating material called "size" is applied. Below this is a winding apparatus which winds the strand into a forming package.



In one type of operation for making fibrous glass preforms for molding, glass roving feeds into a plenum chamber at the top of the machine where it is chopped into short fibers that are then deposited on mandrel. (Photo, Structurlite)

This basic forming package, often known as a "cake," consists of one strand (usually made up of 204 filaments) wound onto a flexible tube. The forming package is rather delicate and hence is merely an intermediate product from which the shippable forms of glass are produced.

Glass surface treatments

The glass filaments are very susceptible to abrasion from one another. Consequently, immediately after forming, a lubricant must be applied. Also, it is necessary to bond the filaments together in the strand; otherwise, they cannot be handled in subsequent operations without becoming very fuzzy. As described above, resins do not adhere to the glass, so an intermediate material known as a coupling agent must be applied to provide adhesion. Thus the surface treatment must serve three functions: 1) lubricant, 2) adhesive or bonding agent between filaments, and 3) coupling agent (a primer).

In the manufacture of certain types of reinforcements (yarns and woven fabrics), the glass is subjected to a great amount of abrasion. Consequently, the demands on the lubricant are great. It is unfortunate that the most effective lubricants act as a deterrent to the resin-to-glass bond. In the manufacture of these materials, therefore, it is necessary to sacrifice the coupling action of the size in order to get sufficient lubrication action. As a result, molding resins will not bond well to the yarns and fabrics, so it is necessary to burn off (heat-

Styrene molding compound for slide viewer housing has chopped glass as reinforcement. (Photo, Owens-Corning)



clean) the size after the weaving is accomplished and then apply a coupling agent. This coupling agent is known as a "finish." Two general types of finishes are used: silanes and "chromes"; the choice is dictated by the strengths required, the costs permitted, and the type of resin to be used (Table I, right).

In the manufacturing of some types of reinforcements (mats, rovings, and chopped strands), the fibers are not subjected to rigorous abrasion. In their processing, it is possible to apply a size that fulfills all of the three requirements. These sizes give good coupling action so that no heat-cleaning and finishing operation is required. Since this extra step in the manufacture is eliminated, these reinforcements are generally lower in cost than those that are finished.

These plastic-compatible sizes contain the same type of silane or chrome materials as is used in the finishes. The amount and type of bonding agent and lubricant can be varied to give a range of "hardness" and "fuzziness." In general, the type of coupling agent is dictated by the strength requirements of the molded part and the bonding agent is decided by the molding techniques to be used.

TABLE I: Types and sources of finishes for fibrous glass

Finish	*Used with*	*Sources*[1]
112 (completely desized)	Silicones	UM, CMS, HG OCF, JPS, F, E, M
111 (partly desized)	Melamines	HG, CO, IVI, OCF, JPS
136	Polyesters, some silicones	UM, HG, CMS, JPS
Volan-A	Polyesters, phenolics, epoxies	CMS, HG, UM, OCF JPS, F, E
Garan	Polyesters	HG, UM, M, JPS, LOF
114	Polyesters	CMS, HG, UM, OCF JPS, F, E
Y-1100	Epoxies, phenolics, melamines	HG, OCF, UM, JPS F, E, CMS, LOF
NOL-24	General-purpose	UM
T-31	General-purpose	JPS
301	Polyesters (Triallyl cyanurates	OCF

[1] Code for sources: CMS—Coast Mfg. Co., Livermore, Calif.; CO—Cordo Chemical Co., Norwalk, Conn.; HG—Hess and Goldsmith Co., a member of Burlington Industries, New York, N.Y.; IVI—Irvington Div., Minn. Mining & Mfg. Co., Irvington, N.J.; UM—United Merchants Industrial Div., New York, N.Y.; OCF—Owens-Corning Fiberglas Corp., New York, N.Y.; M—Menardi, Culver City, Calif.; JPS—J. P. Stevens, New York, N.Y.; F—Flightex Fabrics, New York, N.Y.; E—Exeter Mfg. Co., Exeter, N.H.; LOF—Libbey-Owens-Ford, Toledo, Ohio.

Chopped strands

Strands can be cut into short lengths for use in the manufacture of molding compounds. They are made by passing continuous strands from the forming package through a cutter which chops them into predetermined lengths, usually from 0.5 to 2 inches. Available as bulk fibers, usually packed in bags, they are a low-cost form of reinforcement.

Rovings

Rovings are another low-cost reinforcement. They are used primarily in the preform process, and commonly in the manufacture of rod stock, as well as for local unidirectional reinforcement. Several fabricators also use rovings for the manufacture of chopped strand mats, and some cut the rovings into fibers for molding compounds.

Rovings are made from "cake" packages. A number of continuous strands are wound on a tube to form a cylindrical package; the number of strands can be varied—usually 60 "end" rovings are made.

Spun roving

"Spun" roving is a newly developed, potentially lower-cost form. It consists of one single continuous strand that is looped and wound into a roving-like form. Chopped spun roving is widely used in some forms of molding compounds. Preforming of spun roving has been difficult because of a tendency to stay in clumps, but this has been largely overcome by cutting to no greater than 1-in. lengths, and by breaking up the clumps. This is done by means of a special "spinner" design.

Reinforcing mats

Nonwoven mats are made of either chopped strands or swirled continuous strands that are laid down in a random pattern. The strands are held together either mechanically by stitching or "needling," or by means of adhesive resinous binders. They are available in many thicknesses, usually described in terms of weight/sq. ft.; mats can be obtained in weights from 0.75 to 10 oz./sq. foot.

Mats are lower in cost than woven materials, but are slightly more expensive than bulk chopped strands or rovings. The cost will vary according to the weight and bonding method employed.

The chopped strand mats are made from the basic forming package or from roving. The continuous strands are cut to a predetermined length (sometimes mixtures of lengths are employed) and are dropped or blown onto a forming chain. When resinous binders are used, the mat is passed through a curing oven after the binder is added and then onto the roll-up section of the machine. The mechanical needling for bonding, where used, is done immediately after formation of the mat.

The mats made from continuous swirled strands are formed directly from the fiber-forming bushing. The strand as it is formed is thrown on a moving conveyor. The resinous binder is then applied and the mat passes through a curing oven and into the roll-up section.

All these mats give essentially the same degree of reinforcement to plastics. Their major difference lies in their "handling" characteristics. Needled mats are soft and drapable and are available in heavy weights. The bonded mats are somewhat stiffer, but are stronger. The continuous strand

mats offer greater drawability; that is, they can be molded to more complex shapes than the others without tearing.

Milled fibers

Continuous strands from basic forming packages can be hammermilled into small modules of filamented glass. These fibers are available in nominal lengths from 1/32 to 1/4 inch. They are used largely for anticrazing filler reinforcement in casting resins and in resin adhesives where they give greater body and dimensional stability to the adhesive.

Yarns

Yarns are made on standard textile equipment from the basic forming package. Although primarily an intermediate material in the manufacture of tapes and fabrics, they have been used for rod stock. However, because of lower cost, rovings have largely supplanted yarns as a direct reinforcement for plastics. When yarns are used, they must be heat-cleaned and finished in order to get proper resin-to-glass adhesion.

A form of yarn is the warp beam, in which many parallel yarns are wrapped on a mandrel. This form is not in widespread use, but is a more convenient form for handling a large number of yarns for use as unidirectional reinforcement.

Surfacing and overlay mats

Where the smoothest possible surface is desired on a molding, thin mats of staple monofilaments can be placed over the reinforcement. These mats offer practically no reinforcing, but stabilize the surface resin and allow a heavy resin layer to be used. These mats range in thickness from 0.010 to 0.030 in. and have resinous binders that include treatments for maximum water resistance. Unlike the reinforcing mats, they use filaments of glass that are not collected into bundles. They are made either by the blown-fiber process or by mechanical pulling onto a large drum. These mats are available with a silane treatment for use where water resistance is especially important.

The difference between surfacing and overlay mats is basically in the stiffness of the material. Surfacing mats contain enough binder to make them quite strong; consequently, they are rather stiff. As a result, they are useful as a surfacing material only on flat or

TABLE II: Standard cloth constructions

Style	Warp yarn	Filling yarn	Construction	Thickness	Weight	Breaking Strength — Warp	Breaking Strength — Filling	Weave
Type ECC			ends & picks/in.	in.	oz./sq. yd.	p.s.i.	p.s.i.	
106	900-1/0	900-1/0	56 x 56	0.0015	0.85	46	52	Plain
108	900-1/2	900-1/2	60 x 47	0.002	1.43	70	40	Plain
111	225-1/0	225-1/0	24 x 24	0.003	1.33	50	45	Plain
112	450-1/2	450-1/2	40 x 39	0.003	2.09	100	70	Plain
113	450-1/2	900-1/2	60 x 64	0.003	2.46	100	70	Plain
115	225-1/0	225-1/0	48 x 48	0.003	2.54	100	70	Plain
116	450-1/2	450-1/2	60 x 58	0.004	3.16	150	100	Plain
118	450-1/2	450-1/2	90 x 60	0.005	4.06	190	140	Cr. Satin
119	450-1/2	450-1/2	54 x 50	0.004	2.80	75	60	Plain
120	450-1/2	450-1/2	60 x 58	0.004	3.16	125	120	Cr. Satin
125	450-2/2	450-2/2	36 x 34	0.005	3.93	160	150	Plain
126	450-3/2	450-3/2	34 x 32	0.0065	5.37	225	195	Plain
127	450-3/2	450-3/2	42 x 32	0.007	6.00	250	200	Plain
128	225-1/3	225-1/3	42 x 32	0.007	6.00	250	200	Plain
138	450-2/2	450-2/2	64 x 60	0.007	6.70	300	200	Cr. Satin
140	450-4/3	450-4/3	32 x 21	0.010	8.70	400	290	Plain
142	225-3/2	225-3/2	32 x 21	0.010	8.70	400	290	Plain
143	225-3/2	450-1/2	49 x 30	0.009	8.90	611	56	Cr. Satin
148	450-3/5	450-3/5	30 x 19	0.012	10.10	450	360	Plain
149	225-2/4	225-2/4	30 x 19	0.012	10.80	450	360	Plain
161	450-4/5	450-4/5	28 x 16	0.015	12.20	550	450	Plain
162	225-2/5	225-2/5	28 x 16	0.015	12.20	450	350	Plain
164	225-4/3	225-4/3	20 x 18	0.0145	12.60	500	450	Plain
181	225-1/3	225-1/3	57 x 54	0.0085	8.90	340	330	8 Har. Satin
182	225-2/2	225-2/2	60 x 56	0.013	12.40	440	400	8 Har. Satin
183	225-3/2	225-3/2	54 x 48	0.018	16.75	650	620	8 Har. Satin
184	225-4/3	225-4/3	42 x 36	0.027	25.90	950	800	8 Har. Satin
190	225-1/3	225-1/3	20 x 10	0.006	2.60	92	58	Leno
191	225-1/2	225-1/2	20 x 10	0.005	1.64	82	51	Leno
Type ESS								
248	70/2	70/2	26 x 20	0.012	7.81	140	110	Plain
261	40/2	40/2	20 x 14	0.015	10.32	170	120	Plain
294	25/2	25/2	16 x 16	0.023	14.70	180	200	Plain
Type CSS								
20	44/2	44/2	50 x 34	0.027	19.8	482	283	Br. Twill
28	25/2	50/2	40 x 28	0.029	25.6	459	314	Cr. Satin
40	12.5/1	12.5/1	24 x 20	0.031	21.4	395	282	Twill
93	12.5/2	12.5/2	36 x 14	0.065	48.0	813	383	Cr. Satin

simply-contoured parts. The overlay mats have a small amount of binder so that they are fluffy and extremely drapable. Although not as easy to handle as the surfacing mats, the overlay mats can be used on complex shaped parts.

Woven fabrics

Fabrics were the first type of reinforcement employed. Although higher in cost than mats, they are widely used because they impart high strengths.

Many kinds of fabrics and tapes are available. These vary in weight, thickness, style of weave, coarseness of yarns, and glass fiber diameter. Although both continuous and staple yarns are used, the continuous type is most common because of its higher strength. Because of the wide variety of fabrics available, almost any degree of thickness and directional properties can be obtained. Although most fabrics are "square" (an equal amount of glass runs both ways), unidirectional varieties are popular.

Yarn nomenclature

The nomenclature of fibrous glass yarns differs from that used for other types of textile fibers because of the large variety of nearly identical yarns that are produced. The complete nomenclature consists of two basic parts —one alphabetical, the other numerical. A series of three letters describing the basic glass strand is used in combination with numbers that identify the standard yarn count and yarn construction; for example, ECD 450-3/2. The first letter to be used defines the glass composition—"E" for electrical and "C" for chemical. The "E" glass formula, which is used most often, has excellent electrical properties while the "C" glass is compounded for chemical resistance and is used predominantly for certain types of staple fibers. The second letter indicates the type of fiber—"C" for continuous filament and "S" for staple fibers. The third letter defines the average fiber or filament diameter from which the yarn is made. The numerical values for the third letter are as follows:

D	0.00023 in.
E	0.00028 in.
F	0.00033 in.
G	0.00038 in.

Thus the letter symbol, ECD, given above, indicates a yarn made from the electrical glass formula in continuous filament form with an average filament or fiber diameter of 0.00023 inch.

The numbers following the letters indicate the hundred yd./lb. and yarn construction. The first number (count), 150, 450, 900, etc., is 1/100 of the approximate yardage of basic strand or sliver in one pound. Thus, yd./lb. is easily computed by multiplying this



Nonwoven mats are made either of chopped strands or swirled continuous strands. (Photo, Owens-Corning)

TABLE III: Comparison of reinforcements

		Reinforcing characteristics		*Applications*		
Type	*General description*	*Normal glass content %*	*Directionality*	*General use*	*Typical application*	*Relative materials cost*
Chopped strands	Bulk cut strands	35-45	Multi-directional	Molding cmpd.	Electrical components	Low
Rovings	Rope-like bundle of continuous strands	50-70	As desired	Preforming; unidirectional reinforcement	Machine housings; rod stock	Low
Reinforcing mats	Chopped or continuous strands in nonwoven random matting	20-45	Multi-directional	Parts with simple contours	Translucent sheet; truck body panels	Medium
Milled fibers	Bulk, small filamentized modules	2-10	Multi-directional	Adhesives and castings	Secondary bonding	Low
Yarns	Twisted yarns with after-finish	60-80	Uni-directional	Unidirectional reinforcement	Fishing rods	High
Surfacing and overlay mats	Nonreinforcing monofilaments in random matting	5-15	Multi-directional	To improve surface smoothness	Automobile bodies	High
Woven fabrics	Woven cloths with after-finish available in many styles	45-65	Unidir. or bidir.	High performance parts	Radomes	High
Woven rovings	Coarse, heavy fabrics	50-70	Unidir. or bidir.	High performance parts	Large containers	Medium

number by 100. The second series of numbers following the count number (−1/2, −3/0, −4/4, etc.) designates the number of plies in continuous filament yarns.

The first digit in this series shows the number of original singles (strands) twisted and is separated by a diagonal line from the second digit that indicates the number of these units plied. The total number of strands is determined by the products of these two numbers (0 is multiplied as 1). Plies in staple fiber yarns are shown by a single number separated by a diagonal from the count number.

Fibrous glass cloths are designated by a three letter symbol. The first letter designates the type of glass combination used—"E" for electrical, "C" for chemical. The second and third letters indicate the type of fiber used for the warp and the filling yarn, respectively—"C" for continuous filament, "S" for staple fiber.

Table II, p. 475, listing standard cloth constructions shows only those fabrics developed by Owens-Corning Fiberglas Corp. over a period of several years and currently in industry-wide usage in the electrical, industrial, and plastics fields.

In view of the normal trend in the textile field to develop lower-cost fabrics further to expand present markets and to develop new end uses, weavers have developed a complete line of fabrics using the coarser 150s filament yarns. These can be obtained in plain, unidirectional, satin, and twill weaves. Satisfactory performance, physical properties, and low costs make these fabrics ideal for reinforcement for plastics end uses.

Woven rovings

Woven rovings are a relatively new form of fibrous glass reinforcement, but they are becoming increasingly popular because they are thick, give high strengths to a part, and are lower in cost than conventional fabrics. Like the conventional fabrics, they are available in a wide variety of weaves.

Also known as "roving cloths," they are made by weaving rovings into coarse, heavy, drapable fabrics. Because they are made from rovings rather than yarns, heat-cleaning and finishing is unnecessary; the original size provides satisfactory resin-to-glass adhesion.



Woven fibrous glass rovings are thick, impart high strength to finished products, and are lower in cost than conventional fabrics. (Photo, Owens-Corning)

Economics

As already mentioned, there are significant differences in the costs of the various reinforcing materials. It can be stated generally that those forms that give the highest strength to a reinforced plastics part are the most costly.

The least costly forms (chopped strands, rovings, and mats) impart a nondirectional strength to the molded part. The more expensive woven materials are highly directional; that is, they give strength in one or two directions only. Therefore, a brief consideration of the strengths of panels would show that the woven materials are a much more efficient reinforcement.

However, this can be misleading because the strength of a part made with nonwoven reinforcements is spread in all directions and in many cases this is highly desirable. Also, the glass content of a part has a prime effect on the strength and, because of their geometry, woven reinforcements give substantially higher glass content than nonwoven reinforcements.

Nevertheless, on a cost-per-pound basis, a breakdown of the materials will show the woven fabrics, yarns, and surfacing overlay mats to be the most expensive. The woven rovings and milled fibers are less costly. The reinforcing mats are substantially low-cost reinforcements, while rovings and chopped strands are the lowest-cost forms that are available.

There are many reinforcements available for plastics. Each material offers a particular combination of handling characteristics, degree of reinforcement, and economics. Thus, choice of reinforcement has great bearing on the successful design of a reinforced plastics molding. (See Table III, p. 476, for a comparison of reinforcements.)

References

Consult the Subject Index for additional information concerning fibrous glass fillers. For sources of fibrous glass for reinforcements, see the Directory Index, p. 1018.

"Preform automation," MODERN PLASTICS *34*, 92, (Feb. 1957).

"Veils and/or overlays," MODERN PLASTICS *34*, 95 (Feb. 1957).

"Prestressed reinforced plastics," by S. Goldfein, MODERN PLASTICS *33*, 151 (Apr. 1956).

"The mechanics of plastics reinforcement in tension," by J. A. Outwater, Jr., MODERN PLASTICS *33*, 156 (Mar.); "Concentration of shear at the bonded edge of a fiber under tension," *ibid.* 216 (Apr. 1956).

"Determination of resin content of glass fiber-polyester laminates containing calcium carbonate filler," by S. D. Toner, Analytical Chem. *28*, 1109 (July 1956).

"Polyester laminates—fire-resistant electrical grade," by J. K. Allen, SPE J. *12*, 30 (June 1956).

"Glass-reinforced plastics inspection techniques found," Industrial Labs. *7*, 14 (Apr. 1956).

"Universal glass finish for reinforced plastics," by E. L. Strauss, Materials and Methods *43*, 106 (Jan. 1956).

"Consistency in glass-reinforced moldings," Brit. Plastics *28*, 480 (Dec. 1955).

"Designing for reinforced plastics," by H. L. Darby, Plastics Tech. *1*, 422 (Aug. 1955).

Synthetic and Cellulosic Fibers

BY H. R. SCHWARZ*

RECENT DEVELOPMENTS

Industrial fabrics (American Felt Co.), produced by mechanically interlocking synthetic fibers, have the physical characteristics of wool felt and the thermal and chemical properties of synthetic fibers. The felts have increased resin capillary absorption, greatly reduced surface fiber migration, high abrasion resistance, high impact strength, low moisture absorption, and low electrical conduction properties.

A copolymer of vinyl chloride and acrylonitrile (*Dynel*, Union Carbide Corp.) which is now used in overlays for fibrous glass laminates, improves weathering, reduces shrinkage problems, improves wetting properties, and is low in cost. The material is available in woven or nonwoven fabric in suitable weights for overlays. The surface not only improves abrasion resistance of the laminate, but improves resistance to chemicals and water damage.

Overlay-grade laminating papers impregnated with a new modified melamine resin (*Cyzac 2352*, American Cyanamid Co.) may be laminated directly to wood surfaces to produce, at moderate cost, a transparent, colorless finish with good surface properties. Printed laminating papers impregnated with another modified melamine resin (*Cyzac 2247*) are used in conjunction with the first resin to produce decorative surfaced hardboard for wall panels, door panels, cabinets, low-cost furniture, and TV cabinets.

A fire-retardant stretchable, cross-creped industrial paper material (*X-Crepe*, Cincinnati Industries) has been developed for lamination to vinyl film. The paper, available in roll or sheet form, can be stretched 15 to 60% longitudinally and 15 to 45% laterally. It can also be die-cut, sewn, or slit; fed from rolls into high-speed machinery; glued, cemented, or saturated; formed under heat and pressure; and embossed, indented, or printed.

Chemically shrunk acrylic (*Orlon*) felts available commercially (American Felt Co.) in weights ranging from 0.5 to 8 lb./sq. yd. are expected to have considerable application as overlays in reinforced plastics items.

Synthetic and cellulosic fibers—in nonwoven or fabric form—play an important role in the design of high-pressure or low-pressure laminates. The properties of the individual fibers which are commonly used for these applications are shown in Table I, p. 479.

High-pressure laminates: Cotton is the most important raw material used today for those high-pressure laminates requiring good mechanical properties such as high-impact strength, superior bond strength, and good machining properties. The fibers possess the very desirable combination of good strength and relatively low extensibility. They have the additional advantage of widespread availability and low cost.

Cotton fabrics are generally supplied as grey goods, that is, as they come from the loom, and are not subject to any wet finishing operations. However, they may in some cases be supplied desized or "purified." Desizing consists of removing the starch added to the warp to assist in the weaving operation, as well as the natural oils and waxes inherent in the cotton fiber. The term "purified" is used to denote fabrics which, in addition to being desized or scoured are bleached and thoroughly washed by water to remove any salts or electrolytes that might have a detrimental effect on the properties of the finished laminate.

Other textile fibers, notably nylon, have special properties that make them suitable for many useful laminated products. Nylon, for example, contributes to the laminate good electrical insulating properties, high impact strength, and resistance to bacterial attack. Rayon has found only limited uses in the high-pressure laminating field. High-tenacity rayon has been used for certain applications where high tensile strength is a factor. Acrylic fibers have also been used to a limited extent for electrical laminates.

Low-pressure laminates: Glass fiber is still, by far, the most important textile raw material in this field, whereas cotton has found few, if any, commercial applications, other than as an overlay material. On the other hand, filament nylon fabrics are being used successfully as reinforcements for low-pressure laminates designed as backing boards for bomber fuel cells. Nonwoven Dacron[1] batts used for reinforcing polyester and epoxy resins are said to contribute good abrasion resistance, in addition to improved electrical properties, more flexibility, and lighter weight. They are particularly suitable for the molding of deep-draw laminates since they readily conform to complicated shapes. A recent

* Wellington Sears Co., Inc., 65 Worth St., New York 13, N. Y.
Recent Developments and References were prepared by the editors.

[1] Trademark, E. I. du Pont de Nemours & Co., Inc.

development has been the use of Dynel[2] fabric overlays for glass-reinforced laminates. These overlays greatly improve resistance to abrasive wear, chemical attack, and weather. Acrylic fiber veils or overlays have also been used to provide an extremely smooth finish in automotive applications.

Acrylic, polyester, and nylon fibers are further being adapted as overlays to various materials-handling applications and end-products demanding good corrosion resistance. Synthetic fiber veil-covered surfaces offer improved chemical resistance, ultraviolet light resistance, good dielectric factors, and a harder surface.

Influencing factors

There are many factors involved in the selection of a textile fiber and fabric structure for a plastic laminate. It should be recognized at the outset that the fiber itself is the important element of the fabric contributing to the strength of a laminate (see Table I, right). When a continuous filament yarn fabric is used as reinforcement, the tensile strength of the laminate is influenced directly by the yarn strength. In the case of a laminate reinforced with a spun staple yarn fabric, on the other hand, neither the strength of the yarn nor the fabric itself has a direct bearing on the tensile strength of a laminate. It is the strength of the individual fibers which is the significant factor in the strength of the laminated product. The fibers in the spun yarn structure are surrounded by the resin which prevents them from shifting when stresses are applied to the laminated stock. Thus, the ultimate strength of the yarns themselves is never realized.

Another important factor having an effect on the laminate strength is the elongation of the fiber. Assuming that the elongation characteristics of the fiber and the resin are approximately the same, it is the fiber strength that is the determining factor within the limits of the effective adhesion between the fiber and the cured resin. To illustrate the importance of both strength and elongation in laminate strength properties, consider high-pressure laminates reinforced with spun nylon fabric. The tensile strength of nylon-base laminates is not as high as that of laminates reinforced with cotton fabrics. For, despite the higher strength of nylon, the fiber's lower modulus of elasticity does not permit the superior strength of the fiber to be fully utilized when incorporated in a rigid plastic structure. On the other hand, the fiber tenacity has a direct influence on the high impact strengths possessed by the nylon-reinforced laminates.

Fabric specifications covering textile materials for laminating purposes generally include minimum breaking strength requirements. One of the principal reasons, of course, is to insure uniformity of material. Fabric breaking strength can be easily determined by any textile laboratory. Provided minimum strength values are met in addition to other specification requirements, it is a definite indication that the fabric in question is up to standard.

Generally, plastics produced by laminating techniques are rigid, having a high modulus of elasticity. Accordingly, stretchability and resiliency normally associated with fabric structures formed by the interlacings of twisted yarns are not factors affecting the properties of the laminated material. These fabric characteristics, however, are significant in the case of textiles for postforming stock. Nevertheless, the particular form in which the fibers are introduced to the resin does have an influence on the ultimate properties of the laminate.

Types of fabric

Nonwoven fabric: Nonwoven fabrics or mats are generally made with random fiber distribution and

TABLE I: Properties of textile fibers

COTTON'S natural fiber twist enables spinning of strong yarns. Cotton is durable, absorbent, resistant to stretching and heat; it bulks and insulates well, has high wet strength. Resistance is low to acids and mildew, but high to alkalies and solvents.

RAYON, a regenerated cellulose in staple or filament form, is industrially most important in *high-tenacity* form, with outstanding qualities of high strength combined with light weight. Many of its other properties are similar to those of cotton, but wet strength is lower.

FORTISAN[1] is a strong filament yarn of oriented and saponified regenerated cellulose. The new, highly oriented "Fortisan-36" has exceptional strength, stretch resistance, and dimensional stability. Chemical and other characteristics resemble cotton.

NYLON is a chemically synthesized organic fiber, both staple and filament, available in high-strength forms. It has very high tenacity, wet or dry; excellent abrasion- and flex-resistance; toughness; elasticity; resistance to heat and alkalies; excellent electrical qualities.

ORLON[2] acrylic staple fibers are light, strong, resilient, dimensionally stable, low in moisture absorption and are nonconductors of electricity. They show good resistance to heat, strong acids, mildew, bacteria, ultra-violet rays, and atmospheric effects.

DYNEL[3], staple fiber of vinyl and acrylic origin, has many properties similar to Orlon. Though sensitive to heat, Dynel has excellent resistance to strong alkalies as well as acids, and will not support combustion.

DACRON[2], polyester staple fiber, is water-repellent, quick drying, dimensionally stable, with good electrical properties. It has good strength, flex life, and shape retention, and resists abrasion, heat, and many chemicals.

[1] Trademark, Celanese Corp. of America
[2] Trademark, E. I. du Pont de Nemours & Co., Inc.
[3] Trademark, Union Carbide Corp.

[2] Trademark, Union Carbide Corp.

bonded with resins which are compatible with those used in the laminating process. Laminates made from the random nonwoven material have impact, flexural, and tensile strengths just as high in the diagonal directions as in the usual machine and cross-direction.

Nonwoven fabrics are used in the manufacture of laminated products requiring sharp projections or edges, mirror-like machined surfaces, and superior mechanical strength. An early application was the noiseless gear for electric clocks. The balanced strength characteristics of laminates with random fiber reinforcement made it possible to produce fine-toothed gears without weak spots in the teeth. High-speed machining of the laminates without damage was made possible.

Another good example of the unusually good mechanical properties of laminates reinforced in this manner is the textile bobbin head. Tests have shown that heads fabricated from these laminates have nearly twice as much impact-fatigue resistance as the next strongest type (paper-and-canvas-reinforced).

There has also been some activity in the use of papers based on synthetic and cellulosic fibers for reinforcing laminates, but most of the work in this area is still largely in the experimental stage.

Woven fabrics: The density and positioning of the individual fibers in the fabric structure must be considered in developing the optimum laminate to be used for a given application.

Fiber in fabric form has certain advantages which are utilized in laminating production.

Probably the single most important factor is the extremely uniform distribution of the fiber in woven fabrics. This high degree of uniformity enables the plastics manufacturer to combine many layers of varnished cloth together to form a laminate having a homogeneous structure. Furthermore, fabric has the advantage of mechanical strength, enabling it to be processed readily without damage by continuous methods.

Generally speaking, the laminating varnish has a better opportunity to penetrate the more porous structure of spun staple yarns than the more compact and denser filament yarns, especially in the case of the heavier-weight fabrics. In many cases, economic considerations necessitate the use of comparatively heavy fabrics for mechanical laminates, because of their lower cost per pound.

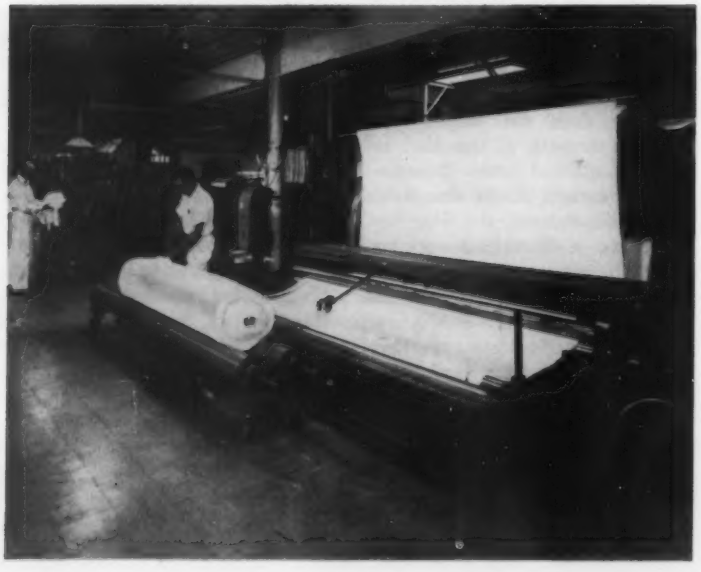
The amount of yarn twist has a definite bearing on the degree of resin penetration. Fabric woven from softly twisted yarns although not necessarily so strong from a textile standpoint, nevertheless, allows more resin to penetrate the fabric structure. This results in a stronger laminated product. Another influencing factor on the properties of fabric-base laminates is yarn crimp. Highest tensile strengths are realized by having the fibers lie as flat as possible in the plane of the laminate. In this position the full reinforcing effect of the individual fibers can be utilized to the best advantage. On the other hand, fabrics with a high yarn crimp tend to increase the shear strength of the laminate.

The effects of the various components must be carefully considered in the selection of a fabric construction for a particular end-use. In the majority of cases it is desirable to use a fabric having an equal distribution of strength in the warp and filling in order to obtain balanced strength characteristics in the laminated product. By cross-laminating, however, it is possible to use fabrics with unequal strength distribution and still obtain laminates with balanced properties. For certain applications it may be advantageous to have the strength largely in one direction; in these instances, so-called unidirectional fabrics are employed.

The bond strength of laminates, and by this is meant the adhesion between the fabric plies, is affected to an important degree by the surface characteristics of the fabric. A softly twisted spun yarn construction, presenting a fibrous surface and a high degree of fabric "pebble" or surface texture, results in an interlocking effect when the fabric layers are combined during the laminating process by means of heat and pressure. At the other extreme, a smooth surface, finely-woven fabric made from continuous filament yarns may have a tendency to delaminate easily. Therefore, a fabric of the latter type should not be used for those applications requiring a high degree of bond strength.

The tightness of weave, as affected by warp and filling yarn

Dacron fibers are made into batts in needle loom. Used as a reinforcement or an overlay, the batts are more drapable than bonded mats. (Photo, Troy Mills)



sizes and thread count, also has an effect on the laminate properties, particularly from the standpoint of resin impregnation. It is the combination of yarn and fabric structure that influences the properties of the final laminated product. The type of weave must also be taken into consideration in view of its effect on yarn crimp, porosity, and surface characteristics.

Types of weave

As an indication of just how many different types of weave are available to the laminator, listed below are definitions of standard cotton industrial fabrics based on generally accepted trade practice.

Lawns: These are lightweight, high-count staple fabrics made in plain weaves from both carded and combed cotton yarns, generally with yarn numbers 60s or finer.

Print cloth: Made from coarser yarns than those used in lawns, generally 30s warp yarn and about 42s filling yarn. Print cloths are woven in a large number of thread counts.

Sheetings: The term "sheeting" is applied to a plain-weave cotton fabric using carded singles yarns for warp and filling.

Drills: Drills are 3-harness twill constructions, made with the ends interlacing, 2 up and 1 down. Woven with carded singles yarns, the drills are available in a wide range of widths and constructions.

Osnaburgs: This term is applied to plain-weave fabrics which are of lower count and of coarser yarns than sheetings. They may be classified as "coarse sheetings." In count, they range from about 24 by 16 to 40 by 32.

Ducks: Cotton duck is a broad term used to denote a considerable range of firm, heavy, plain-weave fabrics. In the case of so-called flat ducks, singles warp yarns are woven in pairs. There are several general types of duck based on differences in construction as follows: a) duck in which both warp and filling yarns are singles; b) duck in which the warp yarns are singles and the filling yarns plied or twisted; c) duck in which both warp and filling yarns are plied or twisted.

Following are the definitions of certain types of cotton ducks that have found a place in high-pressure laminating.

Single filling duck: A flat duck of medium weight made from singles warp yarn, sized, two ends woven as one, and singles filling yarn.

Army duck: Army-type ducks are firmly woven ducks in which both warp and filling yarns are plied, free from added warp sizing. They are made in a wide range of widths and constructions. A standard army duck construction used for laminating would be 37 in. wide, 10.10 oz./sq. yd., and 54 by 42.

Numbered ducks: These are firmly woven, plied yarn ducks, made in a great variety of widths and constructions. The weights are designated by numbers, starting with a No. 14/0 weighing 32 oz. to the linear yard, 22 in. wide, all the way to a No. 12 duck, weighing 7 oz. to the linear yard, 22 in. wide.

Chafer duck: This includes a range of plied and singles yarn fabrics, usually constructed to provide an equal thread count and breaking strength in warp and filling. The weight range is from about 8 oz. to 17 oz. to the sq. yard.

Gear duck: Gear duck is so-called because it has had wide use in the manufacture of laminated gear stock. A wide variety of ducks, including single filling, army, and special plied yarn constructions, are used for this purpose and similar applications by the plastics industry. They are generally made to meet user's specifications.

References

Consult the Subject Index for additional information on synthetic and cellulosic fiber reinforcements for laminates. See also the Laminates Chart. For sources of reinforcements, see Directory Index, p. 1018.

"Thermal properties of laminates," by F. R. O'Brien, S. Oglesby, Jr., and P. C. Covington, MODERN PLASTICS *33*, 158 (Aug. 1956).

"Phenolic/paper and silicone/glass laminate in R.F. heating equipment," Brit. Plastics *29*, 368 (Oct. 1956).

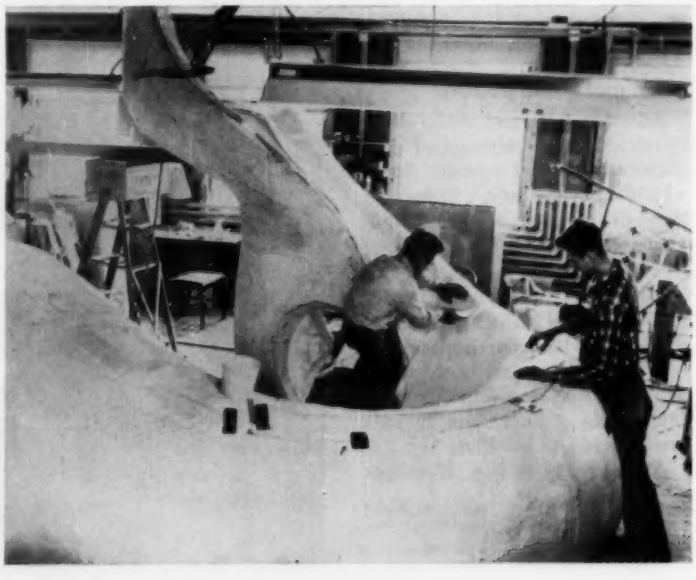
"Plastics-paper combinations," by E. C. Jahn and V. T. Stannett, SPE J. *12*, 32 (Jan. 1956).

"Copper-clad phenolic/paper laminates for printed circuits," Brit. Plastics *29*, 14 (Jan. 1956).

"Reinforced plastics from cellulose fibers," Plastics (London) *20*, 336 (Oct. 1955).

"Dielectric breakdown properties of thermosetting laminates," by N. A. Skow, Trans. ASME 77, 701 (July 1955).

In manufacture of reinforced plastics playground slide, overlay woven of Dynel acrylic fibers is used to provide abrasion resistance. (Photo, Union Carbide)



Asbestos Reinforcements

BY D. V. ROSATO*

Asbestos reinforcements are available in a variety of forms, such as felts, mats, papers, asbestos molding compounds, prepared asbestos fibers, and cloth or yarn, and are used to provide, among other advantages, increased stiffness, heat resistance, chemical resistance, and insulation.

Some 30 or more minerals of fibrous crystalline structure comprise the asbestiform group, but only six have economic significance: chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite. The type of asbestos most commonly used in commercially available felts and mats is chrysotile, a hydrated silicate of magnesium. Felts and mats are available with all-chrysotile fibers or a combination of chrysotile fibers with cotton, rayon, or glass fibers. When a combination of fibers is used, lower mechanical properties are generally obtained. The principal purpose for combining fibers is to permit products with variations in properties which will be in direct proportion to cost of products. The all-chrysotile felt or mat makes available plastics with exceptionally high modulus of elasticity values. Values ranging from 5 to 6 million p.s.i. are obtained in the laminate.

Felts, mats, and papers

Asbestos felts and mats, (e.g., Pyrotex[1]), are composed of mechanically opened asbestos fibers which have been processed through carding machines that arrange the fibers in a tenuous web. The carding process is a basic step in the manufacture of practically all asbestos textiles. Sheet materials approximately 10 mils in thickness are referred to as "felts"; sheet materials with thicknesses greater than 10 mils are referred to as "mats."

Asbestos papers (e.g., Novabestos[1]) are the result of a chemical process that produces dispersed, single, long-fiber asbestos. Products made with this material have an extremely fine, smooth, uniform, flexible, and long fibrous structure. They differ from commercial papers in that they contain no filler materials such as cement or reprocessed pulp.

Asbestos fabrics have been used successfully for a number of decades. Products have generally been made by high-pressure curing where electrical and/or mechanical requirements exist.

Processing

Standard reinforced plastics molding techniques can be used in fabricating asbestos-reinforced plastics. Felts are readily handled in wet or dry lay-ups. Felts containing no resin binder can be wet readily, but cannot be handled in large unsupported sheets.

Felts are also available with approximately 3 to 5%, by weight, of a binder which is compatible with all the different resins (phenolic, epoxy, silicone, etc.). These felts can be used in unsupported sheets. The ability of these felts to wet satisfactorily with resins and retain wet strength can be illustrated by the fact that they can be used in continuous laminating processes or put in vertical drying towers for the purpose of making prepregs. Felts with binders can be sent unsupported through 60-ft. vertical towers.

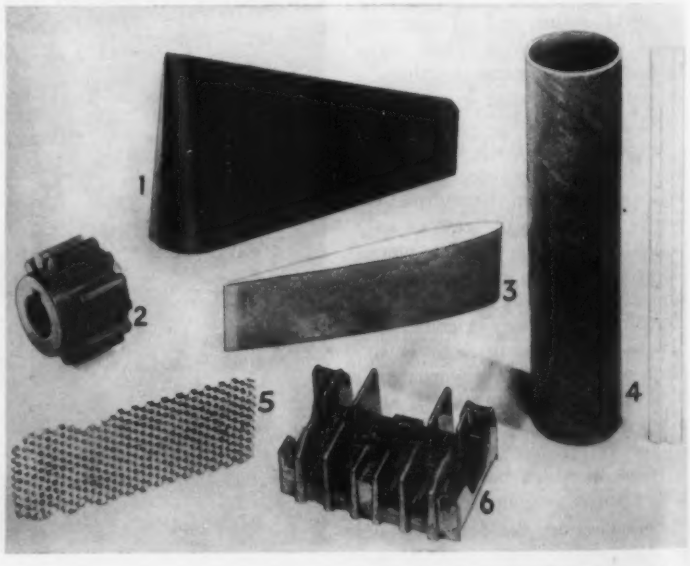
Bulk factor of felts or mats is approximately 3 to 1 when curing pressures of 400 to 500 p.s.i. are used. The ratio is 3 to 2 when curing pressures are 10 to 50 p.s.i.

In parallel lay-ups using asbestos felts or mats, the physical properties are in the ratio of 3 to 2 when going from the longitudinal to the transverse direction. The longitudinal direction is the machine direction of product. These products can be oriented in various patterns in order to produce laminates having varying directional properties. To obtain an isotropic sheet (properties the same in all directions in the plane of the sheet), the felts need only be laid up 90° to each other.

Asbestos molding compounds

Asbestos fibers are used as reinforcements or fillers for molding or premix compounds. These

Applications for asbestos-reinforced plastics include: 1) missile fin; 2) pinion gear; 3) airfoil section; 4) rocket launcher body tube; 5) honeycomb core; and 6) electrical switch gear. (Photo, Raybestos-Manhattan, Inc.)



* Chief Engineer-Product Mgr., Reinforced Plastics Dept., Raybestos-Manhattan, Inc., Manheim, Pa.

References were prepared by the editors.

[1] Trademark of Raybestos-Manhattan, Inc.

molding compounds include various types of resins (polyester, epoxy, melamine, etc.). Molders use fibers to improve or obtain the following characteristics: dimensional stability; elimination of gloss on surface; impact; chemical resistance; flow of molding compound, in use with or without other reinforcements; reduced warpage; heat and flame resistance; durability; and lowered cost of compounds.

For certain applications, asbestos sheet materials require filler material in order to take care of nonuniform cross-sections. Asbestos-phenolic resin molding compounds are available that can be used for such purposes in conjunction with sheet materials or alone.

Asbestos preforms

Basically, two types of preform machines are in use. One is equipped with an automatic cutter which cuts roving at a uniform rate. The cut roving in turn is deposited on a preform screen. Chopping equipment differs from that used with fibrous glass in that glass choppers need only "bend" glass, whereas asbestos has to be "cut." The second machine is a "blown" preform type in which prechopped glass and asbestos fibers (with or without resins) are blown through a hose onto a preform screen.

Other types of machines and techniques involve preparing a slurry or water mixture which contains asbestos, etc. A perforated screen dipped into the slurry has asbestos, etc., dispersed on it when removed. Drying and resin treatment then follow this operation.

Laminate properties

The physical properties of laminates are largely dependent upon the type of mold, molding pressure, and the asbestos-resin ratio. These characteristics are similar to those found in other types of reinforced plastics. The flow characteristics of laminating resin contained in treated felts or mats should be established to coincide with the molding or laminating pressure and techniques to be employed. The resin flow is determined by weighing 4-in. squares

CORDOPREG® + MOBALOY®



NEW PREPREG PRODUCTS FOR AIRCRAFT, MISSILES, ROCKETS



Quality-controlled pre-impregnated glass fabrics and uniform tension rovings available with these stabilized CORDO RESINS:

- **POLYESTER**
- **SILICONE**
- **EPOXY**
- **DAP**
- **HIGH TEMPERATURE PHENOLIC**
- **HIGH TEMPERATURE EPOXY**

approved and specified by leading manufacturers for aircraft, guided missiles and rocket components.

CORDOPREG + MOBALOY offers outstanding advantages to the molder, as it may be easily and rapidly handled in die cutting and press loading and is ideal for automatic processing.

CORDOPREG + MOBALOY virtually eliminates waste, assures consistently high quality with increased press output, and lowers tool and overhead costs.

CORDO leadership in research and development is available for economical, accurate evaluation of new applications. Write for catalogs and full information.

CORDO
MOLDING PRODUCTS INC.
230 Park Avenue • New York 17, N.Y.
Dept. C-2

®Registered



SOLKA®-FLOC

Pure, Finely Divided Wood Pulp

A versatile formulating aid that gives strength to your plastics molding compounds

Solka-Floc* is a chemically pure wood cellulose, non-abrasive and relatively inert to acids, alkalis and solvents.

Through its use as a formulating aid you can obtain strength, heat stability, improved wear when used with phenolic, urea, melamine and polyester resins.

Solka-Floc is available in a wide range of grades and prices to meet your specific requirements. For samples and details on how Solka-Floc will benefit your product, write Dept. FL, at our Boston Office.

*Available in Canada from Brown Forest Products, Ltd., Montreal (Alpha Floc)

BROWN COMPANY

Berlin, New Hampshire

General Sales Office: 150 Causeway Street, Boston 14, Mass.

(approximately 25 g.) before and after pressing for 5 min. at 300° F., under 400 p.s.i. pressure.

Asbestos felts and mats are specifically tailored for high physical, electrical, and/or high-temperature applications. Typical parts using these products are missiles, rockets, aircraft structures, firewalls, electrical generators, turbine wheels exposed to heat, radomes, flame-resistant paneling, honeycomb construction, heat-resistant decorative paneling, etc.

Types of laminates

Asbestos-phenolic laminate: To date, the majority of the work involving asbestos felts and mats has been with phenolic laminating resins. Asbestos-phenolic laminates can be used at elevated temperatures. Parts have withstood temperatures of 2500° F. for 60 sec., and 3500° F. for 6 to 10 seconds. Parts requiring low strength have been used in continuous exposure to a temperature of 300° F. for periods of at least 1 year. Where thermal insulation was of prime consideration, these products have been subjected to 5000° F. for short periods. Where dimensional stability of parts is required, these products are useful. Laminates and molded products have been subjected to temperatures of 300 to 350° F. in dry or wet steam with relatively no change in dimension or strength.

To develop maximum strength, parts have been postcured for different cycles of time and temperature ranging from 1 to 5 days, and 250 to 500° F. Time and temperature cycles for postcuring depend on thickness and shape of part. If blisters or delamination occur during the postcure, increased curing time at lower temperatures or longer press cure cycle is recommended. Postcuring need not be conducted with parts in press mold. For requirements where initial strength does not have to meet maximum properties and it is desired to subject parts for long periods of time at 300 to 350° F., no postcuring is recommended.

Asbestos - silicone laminates: Felts impregnated with silicone resin produce exceptionally heat-resistant laminates or moldings. As an example, 5 to 10 hr. ex-

Creative papers from the mills of MOSINEE



Mosinee's wide experience in working with major plastics manufacturers may pay off for you. For years their research and development departments have been custom-designing paper to suit specialized plastics applications.

In the plastics industry...

low-cost papers replace expensive traditional materials

Offering a combination of economy and versatility, Mosinee creative papers are proving their worth throughout industry. These special sulphate papers are being used where paper was never before even considered. And they're performing as well or better than the more costly materials previously used.

With scientifically controlled processes, Mosinee can produce papers possessing an amazing variety of chemical and physical properties including high dielectric strength . . . mold, flame, water and corrosion resistance . . . resin holdout or absorbency. Especially important, Mosinee can quantity-produce these papers with dependable uniformity.

HERE ARE 6 GOOD REASONS FOR CALLING ON MOSINEE FOR YOUR SPECIAL SULPHATE PAPERS:

1. A proven record for creating outstanding custom-tailored papers
2. Extensive research facilities
3. Specially developed quality controls
4. Nearly 50 years of experience
5. Technical consultants in your area
6. Flexible production capacity

Chances are Mosinee may already have answers to fabricating, processing or packaging problems you are now working on! Mail the coupon below for more complete details.

Mosinee
PAPER MILLS COMPANY
Mosinee • Wisconsin

MOSINEE PAPER MILLS CO., Dept. MPE-7, Mosinee, Wisconsin
Please furnish details on how you can create special papers to meet our needs.

NAME.....
FIRM.....
PRODUCT.....
ADDRESS.....
CITY..... ZONE..... STATE.....

posure of these parts at [illegible]° F. produces relatively no [illegible]sual change and the parts reta[illegible] their strength properties.

Heat resistance

Being a mineral, asbes[illegible]os has great heat resistance, and [illegible]n be heated to high temperatures without burning. This is one of the major reasons for its use in reinforcing plastics.

When asbestos is combined with various resins, its behavior cannot be directly related to asbestos alone. As an example, asbestos-phenolic laminates, when subjected to 5000° F. for a short period of time, will retain mechanical strength properties; asbestos alone would retain very little of its strength properties. However, the fact that asbestos alone can be subjected to temperatures above 2500° F. without complete decomposition or melting enables asbestos-reinforced plastics to retain a good portion of their strength at elevated temperatures when combined with heat-resistant resins.

Applications

Asbestos felts and mats are specifically tailored for high physical, electrical, and/or high-temperature applications. Typical fields of interest for these materials include: missiles, rockets, aircraft structures, firewalls, electrical generators, turbine wheels exposed to heat, radomes, flame-resistant paneling, honeycomb construction, and heat-resistant decorative paneling.

References

Consult the Subject Index for additional information concerning asbestos reinforcements. For sources of reinforcing materials, see Directory Index, p. 1018.

"Asbestos reinforcements," by D. V. Rosato, MODERN PLASTICS 33, 140 (July 1956).

"What's new in reinforcements," MODERN PLASTICS 33, 81 (Feb. 1956).

"Asbestos reinforcement for plastics laminates," by D. V. Rosato, SPE J. *12*, 24 (Aug. 1956).

"Asbestos-reinforced low-pressure laminates," by J. B. Campbell, Materials and Methods 43, 103 (Feb. 1956).

Plymouth Cotton Flock and Filler for plastics reinforcement



● Even in strong sunlight, you can see that Plymouth cotton flock and filler is spotlessly clean. In fact, it is recommended as a filler in thermoset dinnerware and other products where CLEANLINESS and IMPACT strength are vital.

Plymouth flock and filler is always completely *uniform*, assuring you of products with full, *lasting* impact strength.

Plymouth cotton flock and filler is made from the finest, selected 100% cotton materials, carefully reduced to the precise size your particular product requires. This careful grading process, plus "sunlight cleanliness," makes Plymouth cotton flock and filler a superior one.

Test Plymouth flock and filler in your own plant. Write for samples and full details.

PLYMOUTH FIBRES CO., INC.

197 PLYMOUTH STREET BROOKLYN 1, NEW YORK

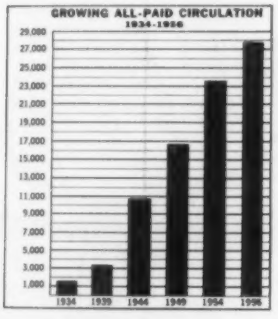
How to test for ADVERTISING IMPACT in the plastics field

If you have anything to sell ... chemicals, materials, machines, or equipment ... that the fast-growing plastics industry can use, now is the time to establish your company firmly in the plastics market. In 1956 material production reached the four billion-pound level ... and the outlook is for continued expansion. The place to start your sales program is in MODERN PLASTICS, *the one plastics magazine that stands up to this 3-way check for maximum advertising impact:*

CHECK THE CIRCULATION: The 29,000 distribution of MODERN PLASTICS includes the *largest paid* circulation covering the two basic areas of the plastics market. These are:

1. the plastics industry itself—(a) the processors who mold, extrude or otherwise fabricate plastics materials into products and parts; (b) the plastics materials suppliers.

2. the "end users" of plastics in many different industries—who incorporate plastics components in the products they make. (Soon as their volume is big enough, they often set up "captive" plastics plants, or buy out existing plants and incorporate them into their own operations.)



Because MODERN PLASTICS plays a major role in the field's continuing growth, because it is constantly in the vanguard of new product explorations, it is today the recognized voice of these plastics converters and users. As a result, it's literally "the" plastics magazine, with a record-high, all-paid circulation that has matched the market's growth stride for stride since the industry's infancy.

CHECK THE EDITORIAL INFLUENCE: MODERN PLASTICS is the overwhelming choice of executives with buying authority. For example, a Starch survey* made at the 1954 National Plastics Exposition showed that MODERN PLASTICS gives these men more help than all other magazines in the field combined!

The *editorial aim* of MODERN PLASTICS is to increase the use of plastics materials throughout industry ... wherever they fit the job. It serves all facets of the field ... the makers of plastics, the processors and the manufacturers who use plastics in volume, in products of all kinds.

Almost two-thirds of its actual paging is devoted to stories of new trends, new applications, new areas of expansion. The rest is almost equally divided between plastics engineering and production methods ... and the technical problems of plastics chemistry and testing.

CHECK THE ADVERTISING: More advertisers spend more money and use more space in MODERN PLASTICS than in all the other plastics magazines. What do they sell? All this:

Chemicals and Materials—adhesives, synthetic resins, plasticizers, coatings, emulsions, colorants, extenders, fillers, laminates, saturating papers, stabilizers, solvents, wetting agents.

Machinery—hydraulic systems, molding presses, accumulators, granulators, calendars, heat sealers, polishers, slitters, mills, mixers, motors, hobbing presses, embossers, pyrometers, scales, timers, cutting tools, drills, duplicators, lathes.

Services—industrial designing, molding, fabricating, laminating, embossing, hobbing, deep drawing, decorating, postforming, mold making, extending.

Every test will tell you—MODERN PLASTICS has what it takes to help you develop orders for anything you're selling to the plastics field...whether it's or supplies, machinery or services!

*Write for the full report of the Starch survey and for 40-page market data file.

MODERN PLASTICS ENCYCLOPEDIA ISSUE

12 months of effective selling...with a single ad

This is the standard "how-to-do-it" reference work of the plastics field, published once a year (in September). It is packed with vital information ... used the year 'round ... includes a 110-page Buyers' Directory, Plastics Properties Charts, a report on current developments in plastics materials, operating procedures, engineering and methods, and technical data.



IT SELLS! A comprehensive personal-interview study shows the average reader refers to it 40 times a year. Seven out of ten say they bought products as a direct result of using the Encyclopedia.

Annual closing date: June 20th.

A BRESKIN PUBLICATION



ABP ABC

MODERN PLASTICS

575 Madison Ave.
New York 22, N. Y.

one company source for

FABRICS - FINISHES - IMPREGNATIONS



impregnated fabrics

Quality glass fabrics woven, finished, impregnated under our exclusive one-company operation. Consistently uniform products for general purpose and high temperature-high strength uses. Standard and custom systems in phenolic, silicone, epoxy resins. Available chopped for matched die molding.

finishes and impregnations

World's most up-to-date facilities for impregnation of natural and synthetic fabrics, felts, paper and asbestos. Plant accommodates widths up to 72". Standard and custom finishes and impregnations. Research and development facilities available to work with your engineers on new materials.

boat fabrics

Fiberglass fabrics for glass boat makers and for refinishing wooden boats with permanent, maintenance-free hull or deck surface. Special Volan AC finish assures complete wetting out, makes a more perfect bond of cloth to wood. Available in special weights and weaves for various marine applications.

industrial fabrics

Standard glass fabrics at low cost to meet your volume requirements. Custom materials developed to meet individual needs. Wide range of weights, widths, weaves. Available plain, finished or impregnated. Ideal for laminates, production parts, structurals, other wet layup operations.

tooling fabrics

Detail, General and Build-Up fabrics at low cost for tooling applications. All are Volan AC finished for easy layup even on complex forms and for excellent wetting out characteristics. A complete range of standard and custom fabrics mass-produced for low cost.

Call or write for data on Trevarno products and services

Trevarno
GLASS FABRICS

COAST MANUFACTURING & SUPPLY COMPANY

P. O. BOX 71, LIVERMORE, CALIFORNIA • Plants at Livermore and Seguin, Texas

"FLOCK PACKS A SUNDAY PUNCH"



Claremont Flock Toughens Plastics

—makes 'em stand up against hard bouts!

By the addition of Claremont Cotton Fillers, thermosetting plastic formulations become sturdy and strong—create no dimensional distortion—and are in-line, costwise. When end-use requirements demand higher impact, greater tensile and compressive resistance, we suggest you check our "muscle makers" . . . Claremont cotton flock—cotton thread—cotton fabric and cotton cord.

Write for Samples

CLAREMONT WASTE MANUFACTURING CO.

The World's Largest Manufacturer of Plastic Fillers

CLAREMONT • NEW HAMPSHIRE



SURFEX-MM®

Precipitated calcium carbonate. Particle size: 1 to 5 microns. Resin coated. Low oil absorption (18-20 cc/100 grams).

PVC Compounds — Low plasticizer absorption. Low viscosity buildup in plastisols. Excellent dispersion, lowers cost.

Polyester Compounds — Improves finish, reduces shrinkage and mixing cycle. Excellent wettability and dispersion.



MULTIFEX-MM®

Ultra-fine precipitated calcium carbonate. Particle size: .04 to .06 micron. Uncoated.

PVC Compounds — Imparts excellent mar resistance, smooth finish and gloss in vinyl floor tile and injection moldings.

Pre-Mix Polyester Compounds — Imparts whiteness and enamel-like finish. Controls viscosity.



SUPER-MULTIFEX®

Particle size extremely fine: .03 micron, very uniform. Coated with two organic surface agents.

PVC Compounds — Imparts excellent mar resistance, gloss, and minimum whitening on flexing.

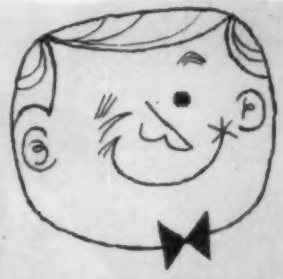
Plastisols and Organosols — Yields thixotropic effect.



KALITE®

Precipitated calcium carbonate. Particle size about 1 micron. Oil absorption 28-36 cc/100 grams. 1% fatty acid coat.

PVC Compounds — Excellent dispersion and gloss. Improves calendering.



NON-FER-AL®

Precipitated calcium carbonate. Particle size: 5 to 10 microns. Uncoated.

Used in plastisols and organosols to reduce cost and maintain low viscosity and good flow.



SUSPENSO®

Precipitated calcium carbonate. Particle size: 1 to 5 microns. Uncoated. Excellent dispersion.

Polyester Pre-Mix Compounds — With Multifex-MM controls viscosity, imparts whiteness, improves finish, cuts cost and shrinkage. Excellent shelf life.

Polyester Compounds — Disperses readily. Imparts whiteness. Reduces shrinkage and cost. Excellent shelf life.

Fabricators' favorites

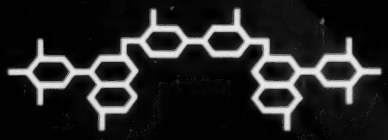
Your nearby DIAMOND sales representative can show you how these products save processing money. Ask him for formulas and detailed cost comparisons. Or write DIAMOND ALKALI COMPANY, 300 Union Commerce Building, Cleveland 14, Ohio.

SALES OFFICES: New York, Philadelphia, Pittsburgh, Cleveland, Cincinnati, Chicago, St. Louis, Memphis, Houston.

DIAMOND DISTRIBUTORS: Carmona & Hawxhurst, San Francisco; Dorsett & Jackson, Los Angeles; Van Waters and Rogers, Inc., Seattle and Portland, U. S. A.; Harrisons & Crosfield (Canada), Ltd.

Diamond Chemicals

CIBA



For reds with the stability needed in the finest plastics

Cromophtal Reds

The Cromophtals represent a logical outgrowth of CIBA's traditional research in dyes and synthetic resins. These entirely new and pure organic pigments with high tinctorial strength and soft texture bring together the working advantages of organic pigments with the high fastness properties associated with inorganic pigments. Being disazo pigments of high molecular weight and salt free, the Cromophtals are highly resistant to migration, light, chemicals, heat, organic solvents and plasticizers. To designers and producers of thermoplastics, particularly PVC, this means assurance that ease of application and dependable results go hand in hand when Cromophtals are specified.

See reverse for listing of CIBA world-wide sales service offices.

CROMOPHTAL is a registered trade-mark of CIBA.

USA CIBA Company Inc.
627 Greenwich Street,
New York 14, N.Y.
Watkins 4-1122

District Offices

Charlotte 1, North Carolina
P.O. Box 1988
Edison 2-3181

Philadelphia 7, Pennsylvania
1220 Arch Street
Locust 3-1303

Rumford 16, Rhode Island
331 North Broadway
Geneva 4-2422

San Francisco 3, California
1230 Howard Street
Market 1-4777

Skokie, Illinois
P.O. Box 216
Juniper 8-3941

Note: Offices listed on this page are for CIBA Dyes and Pigments sales and services only.

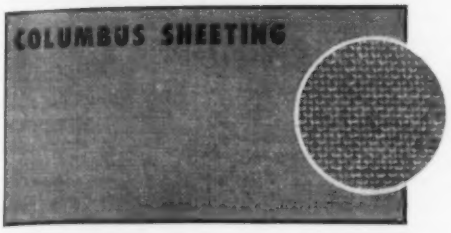
See pages 273-276 for data on newest CIBA resins.

Argentina	Productos Químicos CIBA S.A. Libertad 1056 Casilla Correo 1660 Buenos Aires
Australia	CIBA Company Pty. Limited 22-24, Ryan Street East Brunswick, P.O. Box 22 Melbourne N. II./Vict.
Austria	CIBA Gesellschaft m.b.H. Neustiftgasse 11 Wien VII
Belgium	Société Anonyme CIBA 25, Rue Léopold Courouble Bruxelles III.
Brazil	Produtos Químicos CIBA S.A. Av. Adolfo Pinheiro 3414 Caixa Postal 3678 São Paulo - Est. de S.P.
Canada	CIBA Company Ltd. 1235, McGill College Avenue Montreal 2
China	CIBA (China) Ltd. 5, Queen's Road G.P.O. Box 2582 Hongkong
Denmark	CIBA Farver & Farmaceutika A/S Amaliegade 14 Kopenhagen
France	CIBA Société Anonyme Usines de St-Fons St-Fons (Rhône)
Germany	CIBA Aktiengesellschaft Wehr/Baden
Great Britain	The Clayton Dyestuffs Co. Ltd. Clayton Manchester 11.
India	CIBA Dyes Private Ltd., Royal Insurance Bldg., 14, Jamshedji Tata Rd., Churchgate Reclamat., P.O. Box 4 Bombay 1
Italy	CIBA Industria Chimica S.p.A. 25, Viale Premuda Milano
Japan	Nagase & Co. Ltd., Itachibori Minamidori 1-chome Osaka
Mexico	CIBA de México S.A. Calle del Pino No. 557 Apartado No. 10262 México D. F.
Netherlands	CIBA N.V. Van der Duyn van Maasdamlaan 2 Arnhem
New Zealand	CIBA Company Pty. Limited 189 Featherston Street G.P.O. Box 2103 Wellington C I.
Pakistan	CIBA (Pakistan) Ltd. McLeod Road P.O. Box No. 166 Karachi
Portugal	Produtos CIBA Limitada Rua de Gonçalo Cristóvão, 277 Porto
Spain	CIBA S.A. de Productos Químicos Balmes 117, Apartado 744 Barcelona
Sweden	CIBA Produkter Aktiebolag Drottninggatan 36 Norrköping
Switzerland	CIBA Aktiengesellschaft Klybeckstrasse 141 Basel
Uruguay	CIBA Uruguaya S.A. Maldonado 1220 Montevideo

The biggest line of fabrics for COATING

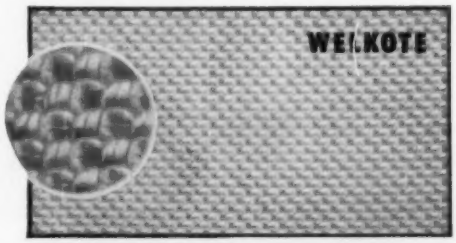


FLEXIBLE AND TOUGH... Wellington Sears broken twills are widely favored by the coating industry, particularly for automobile upholstery, because of their high tear resistance and tensile strength. Their surface smoothness makes a consistently good looking finished product and their flexibility adds good tailoring qualities. Wellington Sears broken twills, soft-filled sheetings and sateens are made up to 72 inches wide in weights of about 6 to 10 ounces per square yard.



VERSATILE BACKING... Uniformly high quality standards of our well-known Columbus sheetings, and also Wellington Sears drills, have established them in a wide variety of coating applications. These fabrics are suited for large-volume use items—wherever high quality, flexibility, easy handling and a minimum of production rejects are essential. Drills are made up to 72 inches wide, 4¼ to 5¼ ounces per square yard. Columbus sheetings are available 40 to 120 inches wide, from 2 to 5 ounces per square yard.

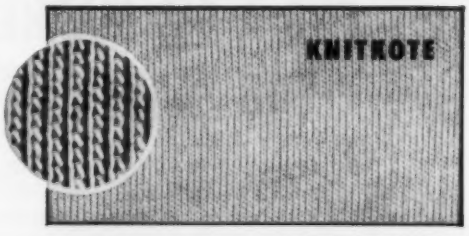
NEW STRENGTH, NEW LIGHTNESS... Welkote is the Wellington Sears filament nylon backing fabric specifically engineered for vinyl and neoprene coating. In truck covers, tents, tarpaulins and other protective coverings, Welkote serves to impart to the coated material superior tear strength, tensile and bursting strength, and flexibility, while giving the finished product remarkable lightness. Available in 36 to 72 inch standard widths (special widths on request), in three basic weights.



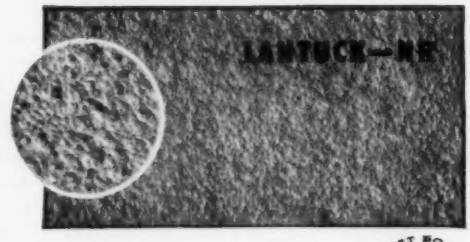
SMOOTH, CLEAN SURFACE... Already established in the upholstery field, and developing rapidly in others, this rayon staple fabric furnishes a coating surface that is outstanding for smoothness and cleanliness. In addition, it contributes superior tear strength. This fabric is made in various standard weaves in widths up to 72 inches and weights from about 4 to 10 ounces per square yard. Other Wellington Sears synthetic fabrics include filament rayon; filament and spun nylon, Dacron*; spun dynel and Orlon**.



VITAL ELASTICITY... KnitKote is a cotton knit fabric specifically designed for backings, supplying vital elasticity with perfect shape retention. KnitKote backing gives leathercloth an ease of tailoring unsurpassed by other backing materials, a feature of great importance to the final fabricator. KnitKote is an outstanding base material for coated automotive and furniture upholstery. It is available in the grey or dyed neutrally, 52 to 60 inches wide, 3.60 to 6.70 ounces per square yard.



NEW RESILIENCE... Lantuck-NR non-woven fabric is designed specifically to reinforce vinyl film or coating. A completely random distribution of nylon and rayon fibers is bonded with a special agent, to give vinyl high tear strength; outstanding stretch and recovery; easier, neater tailoring; smooth even surface—no clothiness; good embossing surface; durability and economy; equal tensile strength, tear and stretch characteristics in *all* directions. This and other Lantuck fabrics for coating are made in a variety of weights, fibers and constructions in widths from 37 to 59 inches.



*DuPont's trademark for its polyester fiber
**Dupont's trademark for its acrylic fiber

Wellington Sears

First in Fabrics For Industry **Wellington Sears Co., 65 Worth Street, New York 13, N. Y.**

Offices in: ATLANTA • BOSTON • CHICAGO • DALLAS • DETROIT • LOS ANGELES • PHILADELPHIA • SAN FRANCISCO • ST. LOUIS

FILLER FOR MOLDING COMPOUNDS

POWMINCO ASBESTOS . . .

. . . An outline of its unusual properties

Powhatan Mining Co. is the exclusive producer of Powminco asbestos fiber, used as a filler and an absorbent and extender in phenolic and polyester resins. It is the only completely fiberized acid resistant asbestos fiber in the United States.

Powminco Asbestos is practically inert. It is not affected by as much as four hours boiling in concentrated hydrochloric acid. This gives it a distinct advantage over ordinary chrysolite fiber when used in molding compounds that require an acid catalyst (phenolics, for example), and in casting resins.

Powminco Asbestos, an anhydrous magnesium silicate, has very little water in its composition. This results in unusually low shrinkage when it is included in plastic compounds used in molding and tooling operations. Other desirable characteristics of Powminco Asbestos are its extremely low magnetic iron, and its very high dielectric strength.

The Powhatan Mining Co. controls the production of Powminco Asbestos from mine to finished fiber, and every processing operation is performed under strict quality controls.

We will gladly supply working samples without charge or obligation. Write to us on your letterhead.



POWHATAN MINING COMPANY

Woodlawn, Baltimore 7 Maryland, U.S.A.

Cable address: "Powminco"

Investigate the packaging field—

IT'S A BIG MARKET FOR PLASTICS!

"Big Market," is right! The men who select the materials used to package the output of America's biggest industries control a market that will hit the 15 billion dollar mark this year.

Typical of the 45 industries that comprise this rich market are companies which manufacture and package foods, cosmetics, chemicals, drugs, candies and tobacco products. In all these highly competitive industries frequent packaging changes are the order of the day. Factors ranging from fascinating sales appeal to plain hard costs influence the men who make the packaging decisions. Consequently, no one type of packaging material (glass, metal, paper or fabric) ever has assurance that it won't be supplanted by another.

And now plastics have entered the arena as directly competitive materials for packaging. In just the last few years they have come to play an increasingly important role—and often at the expense of older, "traditional" materials.

Especially noteworthy is the fact that plastics can be used in the manufacture of almost every basic package type: box, bag, bottle, drum, jar, vial or collapsible tube!

Right now this frontal invasion of the packaging field by alert plastics manufacturers, molders, laminators and fabricators has just begun. And their chief sales tools are the two publications which reach the men who make packaging decisions in all 45 industries—MODERN PACKAGING magazine, issued monthly, and the annual MODERN PACKAGING ENCYCLOPEDIA ISSUE.

Free Details about the Market

Additional data on using these media to help expand your sales to the packaging market are contained in the booklet "The Packaging Field—and how to reach it." Write for your free copy.

•

MODERN PACKAGING

575 MADISON AVENUE NEW YORK 22, N. Y.



Here's how PITTSBURGH FIBER GLASS can help you make better laminated and molded products

1... through top-quality uniformity

Pittsburgh Fiber Glass, produced by the direct melt process under close control, is a top-quality, uniform reinforcement with exceptional strength, dimensional stability and dielectric strength . . . that is fire resistant, heat resistant and odorless.

2... with the right reinforcement for your needs

YARNS—supplied to weavers in any twist or ply in all standard sizes. Reliable uniformity of Pittsburgh Yarns has won its acceptance for use in cloth laminates for military applications.

ROVING—available in a variety of finishes and end counts. Custom wound for your requirements. Static-free Pittsburgh Roving makes pre-form operations easier and faster, produces better quality end products.

CHOPPED STRAND—supplied in lengths ¼" and up. Packaged for convenient handling. High uniform quality reduces percentage of rejects.

3... and technical assistance

You can arrange to have free trials made right in your own plant to show you how Pittsburgh Fiber Glass can help you produce better products. Write or call your nearest Pittsburgh Plate Glass sales office or our main office in Pittsburgh.

Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pa.

PITTSBURGH FIBER GLASS IS A PRODUCT OF THE FIBER GLASS DIVISION OF PITTSBURGH PLATE GLASS COMPANY

Sales Offices are located in the following cities: Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh and St. Louis

FIBER PG GLASS

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY



M & C ALUMINUM SILICATE PIGMENTS (ASP's) . . . *leading fillers for premix and liquid compounds*

ASP fillers are white aluminum silicate crystals of selected particle size that have been process-engineered to remove moisture, sand, mica, water-soluble salts and hard particles. They are essentially non-reactive and insoluble in common solvents. These particles have a thin, flat hexagonal shape as illustrated in this electron photomicrograph (35,000X).

Examine the following characteristics of M & C ASP fillers and you'll see why they are being used by a rapidly growing number of formulators, processors, and molders. ASP's offer you molding ease, excellent finishes and improved properties—often at a substantial cost savings. And Minerals & Chemicals has extensive research facilities and qualified personnel to help you with your specific problems.

Uniformity of Filler Dispersion—ASP's mix easily, stay in suspension, and maintain a homogenous mixture during molding. In premix compounds, they wet out and disperse readily.

Ideal Viscosity and Thixotropic Characteristics—Certain grades of ASP's have low viscosity and thixotropy that permit fast press closure, rapid mold fill-out, and less tendency of the mix to escape after die closure.

Long Pot Life—Because of their natural low reactivity, ASP's have excellent pot life characteristics.

Outstanding Electrical and Physical Properties—ASP's offer a desirable combination of electrical properties including high dielectric strength, high arc resistance and a low power factor. Reasonable quantities of ASP fillers can be used without serious loss in flexural, tensile, compression and impact strengths. They have excellent water and chemical resisting characteristics, and their flat shape and freedom from foreign particles make them non-abrasive.

Positive Shrinkage Control—ASP's aid in controlling uneven cooling and shrinking that cause cracking and low physicals because they prevent excessively high exothermic peaks. The rapid absorption of exothermic heat by ASP's produces a more even internal cooling rate.

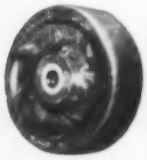
Ease of Molding—ASP's assure molding ease because of their optimum combination of certain properties such as low viscosity, thixotropy, and natural lubricity resulting from their plate-like shape.

Superior Surface Characteristics—ASP's produce smooth surfaces of high gloss because of their refractive index and flat, plate-like particle shape. High opacity or some translucency can be obtained depending on the type of ASP used. The non-reactive nature of ASP's aids in obtaining good adhesion of protective or decorative coatings.

Wide Range of Particle Size Grades—ASP's have a particle size range from 0.55 microns to 4.8 microns with intermediate sizes.



Jeep Hard-Top of ASP filled reinforced plastic has durability yet stylish surface.



Caster wheel with ASP filler has impact strength double the industry standard.



ASP filled airline tray features long life, smooth surface.



Fertilizer hopper made with ASP's at high filler loading is dense, strong, translucent.

FOR ADDITIONAL DATA ON ASP's write for the just-published 4-page Technical Information No. 255, "Minerals & Chemicals Aluminum Silicate Pigments (ASP's) As Fillers in Plastics."

ASP Distributors Offer Service and Warehouse Stocks

CALIFORNIA, SAN FRANCISCO 11
E. M. Walls Company
353 Sacramento Street

CALIFORNIA, VERNON 58
Chemical-Additives Company
3155 Leonis Boulevard

CANADA, BRITISH COLUMBIA
Mackenzie & Feimann Ltd.
845 E. Hastings Street
Vancouver 4

CANADA, MONTREAL 9, P.Q.
Drew, Brown Limited
5410 Ferrier Street

CANADA, TORONTO 18, ONT.
Drew, Brown Limited
50 Titan Road

COLORADO, DENVER 2
George C. Brandt, Inc.
1940 Blake Street

GEORGIA, ATLANTA
Southern States Chemical Co.
1061 W. Marietta Street, N.W.

ILLINOIS, CHICAGO 8
Commerce Petroleum Company
2980 Archer Avenue

***INDIANA, INDIANAPOLIS 25**
Strohm Wise. & Cartage Co.
359 West Ray Street

KANSAS, KANSAS CITY
George C. Brandt, Inc.
3150 Fiberglas Road

KENTUCKY, LOUISVILLE
Wm. B. Tabler Company
P. O. Box 1254

LOUISIANA, NEW ORLEANS 18
Barada & Page, Inc.
Maple & Leake Avenues

MARYLAND, BALTIMORE 1
Van Horn, Metz & Co., Inc.
516 N. Charles Street

MASSACHUSETTS, BOSTON 11
T. C. Ashley Company
683 Atlantic Avenue

MEXICO, MEXICO CITY 6, D. F.
Watson, Phillips
y Cia Sucs S.A.
Apartado Postal #67

MICHIGAN, DETROIT 7
A. E. Fleming Company
1900 E. Jefferson Avenue

MINNESOTA, ST. PAUL 14
George C. Brandt, Inc.
739 Pillsbury Avenue

MISSOURI, ST. LOUIS 7
Barada & Page, Inc.
Ft. of Destrehan Street

NEW YORK, BUFFALO 10
James O. Meyers Sons
290 Larkin Street

NEW YORK, NEW YORK 6
Superior Materials, Inc.
120 Liberty Street

NORTH CAROLINA, CHARLOTTE
Southern States Chemical Co.
1039 Bond Street

OHIO, CINCINNATI 3
C. L. Zimmerman Company
Cincinnati Union Terminal

OHIO, CLEVELAND 14
A. C. Mueller Company, Inc.
616 St. Clair Avenue, N.E.

OKLAHOMA, OKLAHOMA CITY
Barada & Page, Inc.
1700 West Grand Avenue

OKLAHOMA, TULSA 3
Barada & Page, Inc.
26 North Guthrie St.

OREGON, PORTLAND 1
Cordano Chemical Company
56 Southeast Belmont Street

PENNSYLVANIA, CONSHOHOCKEN (PHILADELPHIA AREA)
Van Horn, Metz & Co., Inc
241 E. Elm Street

PENNSYLVANIA, PITTSBURGH 21
J. C. Ackerman Company
789 Penn Avenue

SOUTH CAROLINA, GREENVILLE
Southern States Chemical Co.
25 Peden Street

TEXAS, DALLAS 10
Barada & Page, Inc.
3306 Borich Street

TEXAS, HOUSTON 7
Barada & Page, Inc.
2812 Center Street

WASHINGTON, SEATTLE 4
D. B. Smith Company
1016 First Avenue South

WISCONSIN, MILWAUKEE 14
Benlo Chemicals
1907 South 89th Street

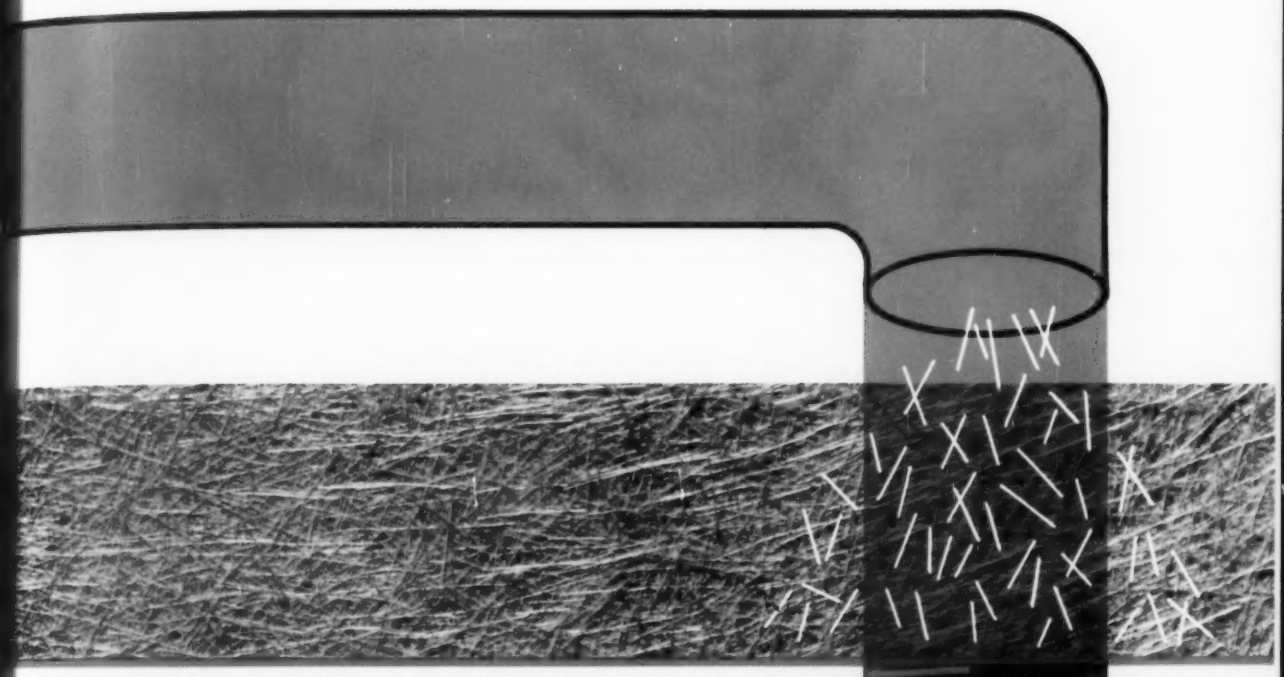
**Warehouse only. For office see Louisville, Kentucky.*

MINERALS & CHEMICALS
CORPORATION OF AMERICA
5758 Essex Turnpike, Menlo Park, N.J. • Cable Address: "MINCHEM"
Leaders in creative use of non-metallic minerals

FERRO FIBER GLASS

reinforcements for plastics

FIBER GLASS REINFORCEMENTS IN EVERY FORM...FOR EVERY PURPOSE



FERRO UNIFORMAT®

FIBER GLASS REINFORCING MAT

Ferro *Uniformat* Reinforcing Mat is made by cutting 14,000 yards per pound, continuous strands, into 2″ lengths and depositing them in a random pattern in the form of a continuous length of firm, bonded mat.

The unique method of producing *Uniformat* results in a mat of uniform weight and texture having equal reinforcing strength in all directions. The greater uniformity of *Uniformat* insures greater overall product strength—eliminates weak areas caused by variations in mat weight and pattern.

Mat integrity is sufficiently high to allow the material to be handled, tailored and laminated without tearing.

Standard roll widths are 50 and 60 inches. These can be varied to any desired width between 25″ and 61″.



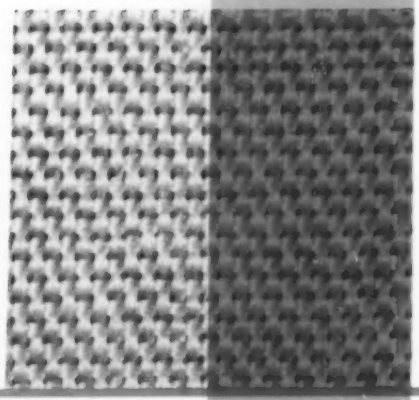
Continuous quality control at Ferro assures that every roll of Ferro *Uniformat* conforms to the customer's "specs"—and to Ferro's high standards for uniformity.

FERRO CORPORATION
FIBER GLASS DIVISION
Fiber Glass Road, Nashville 11, Tenn.
Huntington Beach, California

See next page for
FERRO UNIFAB
FERRO UNIROVE

FERRO FIBER GLASS

reinforcements for plastics

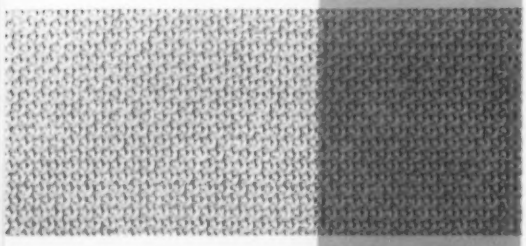


FERRO UNIROVE®

WOVEN ROVING

Particularly useful in plastic reinforcement of heavy industrial products because of its high strength in relation to reinforcement cost.

Write for samples, specifications and prices.



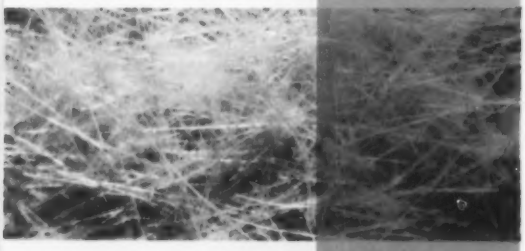
FERRO UNIFAB®

REINFORCING FABRICS

Ferro *Unifab* Industrial Glass Fabrics are made exclusively for the reinforcement of plastics.

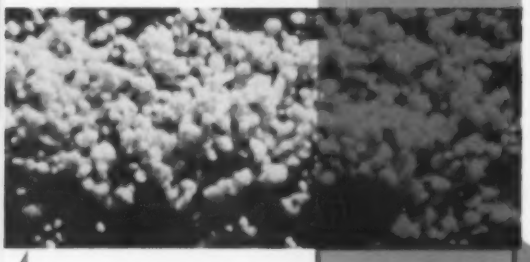
Produced to Ferro's high standards of quality, *Unifab* Fabrics are consistently *uniform* in weight, thickness and weave.

Write for samples, specifications and prices.



FERRO CHOPPED STRANDS

Ferro Chopped Strands are made of the same fiber as in *Uniformat*, cut in lengths of ¼", ½", ¾", 1", 1¼", 1½", 1¾" and 2". Primary uses are in premix formulations, casting resins and certain pre-form applications.



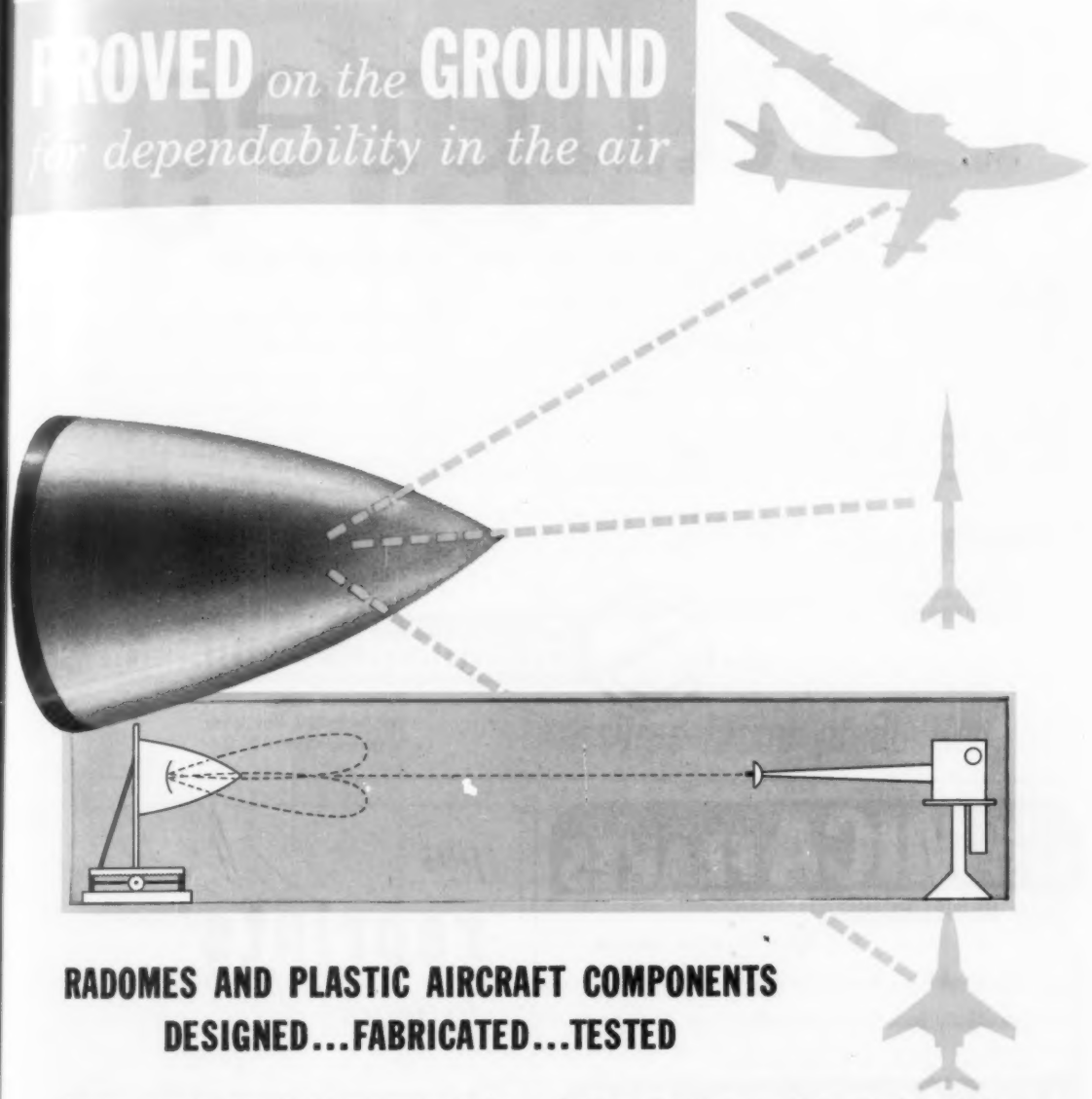
FERRO MILLED FIBERS

Made by milling 14,000 yards per pound continuous strands and reducing them to the form of short lengths of filaments. Supplied in ½", ⅛", ⅛" and ¼" screen sizes. Use Ferro Milled Fibers to help prevent crazing in casting and potting resins, for control of viscosity of liquid resins, for dielectric improvement.

Turn page for data on
FERRO UNIFORMAT

FERRO CORPORATION
FIBER GLASS DIVISION
Fiber Glass Road, Nashville 11, Tenn.
Huntington Beach, California

PROVED *on the* GROUND
for dependability in the air



RADOMES AND PLASTIC AIRCRAFT COMPONENTS DESIGNED...FABRICATED...TESTED

Electronic testing provides for automatic simultaneous recording of boresight error, crosstalk and power transmission. Power sources and R. F. components are available throughout the frequency range of 2 to 35 kmc. plus the U.H.F. range.

In the area of physical testing, Brunswick offers stress fixtures, an environmental chamber and an altitude cycling chamber.

These are just a part of Brunswick's complete facilities covering every phase of radome design, development, fabrication and testing. And behind these facilities lies a continuous research program.

Whatever your problem involving plastic radomes, or other aircraft components of reinforced plastics, metal honeycomb or conventional metal construction, discuss it with Brunswick today. Write: The Brunswick-Balke-Collender Company, 623 South Wabash Avenue, Chicago 5, Illinois.

BRUNSWICK

Stanpreg

pre-impregnated materials

POLYESTER glass cloths, woven rovings and mats combine maximum strengths with flame resistance for commercial and military applications.

EPOXY glass cloths and papers for optimum electrical and physical characteristics. Flame resistant and high temperature resistant types available.

PHENOLIC glass cloths and mats, papers and cotton cloths for high structural and high temperature resistant qualities.

SILICONE glass cloths for maximum strengths at exceptionally high temperatures.

XXXP – Cold Punch Phenolic paper for excellent electrical characteristics combined with outstanding cold punching properties in laminates up to 1/8" thick.

For *your* Reinforced Plastic requirements.

Uniformly resin impregnated and catalized Stanpreg materials are instrumental in achieving maximum production rates while cutting rejects to a minimum. Optimum properties of Stanpreg products are designed to meet a wide range of government and industrial specifications.

Write or call for complete information.

Standard Insulation Co.

80 Paterson Avenue
East Rutherford, New Jersey
Telephone: WEbster 9-5400

LOW COST MICA FLAKES

For REINFORCING

1/2" flakes or other sizes to 100 mesh . . . transparent and colorless . . . chemically inert . . . compatible with all types of resins. Stocks in principal cities.

U.S. MICA CO., INC.

79 PROSPECT ST. STAMFORD, CONN.

FINELY GROUND

MICA FILLERS

From 160 mesh to a theoretical 3000 mesh . . . high impact resistance . . . low moisture absorption . . . and best thermal and electrical properties of any mineral filler. Stocks strategically located for your convenience.

The English Mica Co.

STERLING BUILDING STAMFORD CONN

---

put

reprints

to work!

Reprints of articles, features and news items that appear in Modern Plastics are often surprisingly inexpensive when ordered in quantity. Many companies make it a practice to have stories which have a hearing on their business reprinted for distribution to their own personnel, customers, prospects, stockholders or to other interested groups.

Whenever you see editorial matter of this type in Modern Plastics magazine or the Encyclopedia issue which you can use in reprint form, in quantities of 100 copies or more, write and quotations will be furnished promptly.

INDUSTRIAL MAGAZINE SERVICE

An affiliate of Breskin Publications

575 Madison Avenue, New York 22, N. Y.

Rx for reinforced plastics

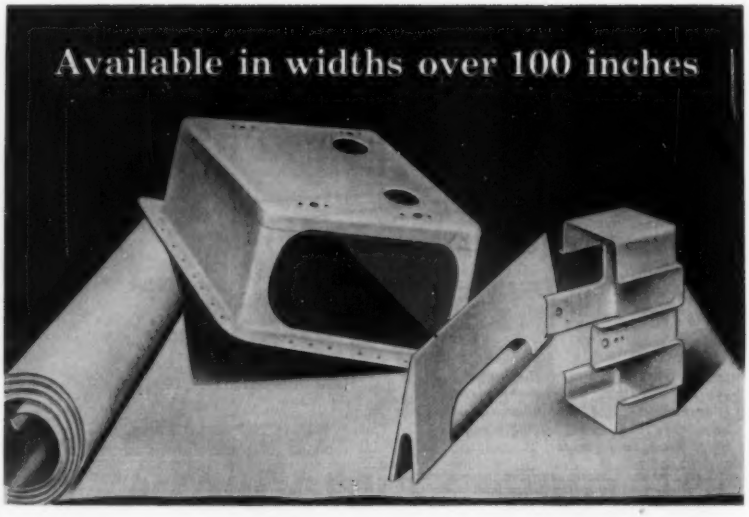
Sandman *resin-ready* fibre glass cloth.

- **vinyls**
- **polyesters**
- **epoxies**
- **phenolics**

Die cut to your pattern
or in rolls.
Just add heat
and pressure.

Let's work it out together
—just phone, write or visit

Eli Sandman Co.
280 GREENWOOD STREET
WORCESTER, MASS.
P. O. BOX 801
Telephone PLeasant 7-7781



New low-cost SUNFORM® Reinforced Plastics For Low Pressure Laminating to meet military specifications— assures faster production

Electro-Tech now offers new polyester resin formulations, as well as other pre-impregnated materials using epoxy, phenolic, melamine and silicone resin systems, and custom impregnations for low-pressure laminating—while maintaining the same high specifications.

SUNFORM saves both time and money. Controlled resin and catalyst impregnation assures fewer rejects and void-free laminates with multiple layers for such applications as, housings, fairings, ducts, sonar domes, radomes, doors, etc.

SUNFORM laminates have high tensile and flexural strengths, and exceptional stability even under extremes of temperature and humidity. Dielectric strength is high, loss factor low and moisture resistance excellent. A selection of colors is available on large orders.

Write for free samples to Dept. E21-5741

Electro-Technical Products
DIVISION OF
Sun Chemical Corporation
113 East Centre Street, Nutley 10, N. J.

DIVISIONS OF SUN CHEMICAL CORPORATION
HORN (paints, maintenance and construction materials, industrial coatings) • WARWICK (textile and industrial chemicals) • WARWICK WAX (refiners of specialty waxes) • RUTHERFORD (lithographic equipment) • SUN SUPPLY (lithographic supplies) • GENERAL PRINTING INK (Sigmund Ullman • Fuchs & Lang • Eagle • American • Kelly • Chemical Color & Supply Inks) • MORRILL (news inks) • ELECTRO-TECHNICAL PRODUCTS (coatings and plastics) • PIGMENTS DIVISION (pigments for paints, plastics, printing inks of all kinds) • OVERSEAS DIVISION (export) • A. C. HORN COMPANY, LIMITED (Canada) • GENERAL PRINTING INK CORPORATION OF CANADA, LIMITED • FUCHS & LANG de MEXICO, S. A. de C. V.

with confidence . . .

LAMINATE AND MOLD THE *MODERN* WAY

POLYPLASTEX

PRE-IMPREGNATED MATERIALS

"β-preg"

POLYESTER
EPOXY
SILICONE

POLYPLASTEX "B-preg" pre-impregnated materials mean uniform resin content . . . volatile content . . . flow—engineered to your technical and production requirements on a wide range of reinforcing materials . . . glass fabric, mat, paper, Dacron, etc.

POLYPLASTEX "B-preg" eliminates wet lay-ups . . . assures uniform, lower cost laminates . . . gives maximum production . . . reduces rejects.

POLYPLASTEX "B-preg" is the *modern* way to make all molded or laminated parts of reinforced plastic—aircraft parts . . . instrument cases . . . flare housings . . . printed circuits . . . furniture . . . luggage . . . decorative and industrial applications, etc.

. . . PLUS
#595 MOLD RELEASE

. . . the proven answer to epoxy and polyester release problems!

POLYPLASTEX UNITED, INC., 870 Springfield Road, Union, N. J.

Do you know all the latest ways to cut your packaging costs?

Are you familiar with new developments in package design that stimulate retail sales?

Are you sure you're using the best kind of package to protect your product from damage?

If you had to answer "No" to any one of these questions, it's likely that you're unnecessarily losing money every business day.

Fortunately there's an easy way out: MODERN PACKAGING magazine! It's the world's most authoritative publication devoted exclusively to packaging problems and their solutions. It analyzes all of the newest developments in packaging—materials, machinery, design and production. It reports each of the latest ways to merchandise packaged products of all types, from frozen foods to monkey wrenches.

The cost of an annual thirteen-issue subscription—including the giant annual Encyclopedia Issue—is only $7.00 in the U.S., its possessions and Canada; $20 elsewhere. You can begin yours today simply by writing us on your business letterhead. We'll bill you later.

MODERN PACKAGING
MAGAZINE
575 MADISON AVENUE,
NEW YORK 22, N. Y.

America's Pioneer Producer
of

FLOCK

FILLER:

"Filfloc" Cotton Flock

Reinforcing flock for inclusion in plastic molding compounds. Available in a range of cut and deniers engineered by our 32 years experience to suit your needs with optimum effectiveness.

SURFACE-COATING:

"Raycote" Rayon Flock

Precision-cut
1 mm velvet finish
½ mm suede finish
Raycote, we believe, can be applied so as to produce the richest effect of any flock on the market. Quality raw material and exceptional precision of cut make it superior.

"Kingkote" Cotton Flock

Random-cut within strict length limits. Produces a suede effect of richness and durability.

Surface Coating of Vacuum-formed Plastics

Containers vacuum formed from plastic film can be coated after forming and can also be pre-flocked before forming. Request details.

WRITE

for latest literature and samples. We make a complete line of natural and synthetic flocks in all colors. 32 years of know-how at your service.

RAYON PROCESSING CO. of R. I.

95 Moshassuck St.
PAWTUCKET, RHODE ISLAND

Solve your abrasion, corrosion and surfacing problems with Troytuf reinforcing blankets

Troytuf reinforcing materials are made of mechanically interlocked synthetic fibers—no binders or adhesives are used. The result is a high strength, light weight, easily handled reinforcing laminate.

Synthetics used are Dacron* polyester and Orlon* acrylic fibers. Troytuf made with Dacron is a general purpose blanket, suitable for a wide variety of applications. Troytuf made with Orlon is especially fitted for jobs involving weather exposure, and for finished laminates requiring paint.

Troytuf blankets give you

- **high abrasion resistance**
- **excellent electrical properties**
- **uniform fiber loading, without resin rich corners**
- **high resistance to mineral acids**
- **elimination of pre-forming**
- **safe material for food containers and utensils, because of the absence of sharp fragments**
- **smooth, attractive surface finish**
- **good formability after curing**
- **low moisture absorption**
- **no shelf life problem—because no binders or adhesives are used**

Troytuf blankets are especially suitable for

molding deep-draw pieces—because the loose blanket readily conforms to irregular shapes

printed circuitry; radomes, other electrical and electronic applications—because of Troytuf's excellent dielectric and electronic transmission properties

general reinforcing applications—because of Troytuf's light weight and great strength

* * *

Why not get the full story. Write for your free copy of the *Troytuf Technical Data Booklet.* It gives extensive information about properties and applications, and includes a price list.

REINFORCING **Troytuf** BLANKETS

Troy Blanket Mills, 200 Madison Ave., New York 16, N. Y.

* Du Pont registered trademark

primary source for all glass fiber requirements

SURFACING MATS
VEILS
TAPES
MATS
REINFORCING
in a broad range of colors, sizes, weights and types

Modiglass Fibers offers new horizons in surfacing, reinforcing, structural and decorative applications. Dependable delivery and a wide variety of glass fiber materials are *plus* values when you order and use Modiglass Fibers products.

For detailed specifications and prices, write to Modiglass Fibers, Inc., 70 Pine St., New York 5, New York.

MODIGLASS FIBERS, INC.

Executive Offices:
New York, New York
Research Laboratory:
Florham Park, N. J.
Plant: Bremen, Ohio

SPECIAL FABRICS for COATING & LAMINATING

FLIGHTEX
FLIGHTEX FABRIC
FABRICS

- GLASS
- COTTON
- VINYON
- DYNEL
- ORLON

If you use special fabrics for coating and laminating, you'll find Flightex a dependable source of supply. Our staff of engineers is at your service to help solve your problems.

Write for Complete Information

FLIGHTEX FABRICS, Inc.
87 Worth Street New York 13, N. Y.

MICA
WATER GROUND
Franklin
MINERAL PRODUCTS COMPANY, INC.
Franklin, North Carolina

Samples from either plant

Fillers greatly modify Characteristics or Workability of Basic Resins and Compounds.

Water Ground Mica is unique among fillers because of its . . .

- THIN, LEAFY PARTICLE SHAPE
- PARTICLE SIZE DISTRIBUTION
- TOUGH, NON-BRITTLE PARTICLE
- RELATIVE SOFTNESS (MOHR 2.5)
- CHEMICAL INERTNESS
- HIGH DIELECTRIC STRENGTH
- LOW POWER DISSIPATION FACTOR EVEN AT HIGH TEMPERATURE
- SMOOTH SURFACED PARTICLE

Try WATER GROUND MICA to modify . . .

COEFFICIENT OF EXPANSION
PERMEABILITY
TEMPERATURE STABILITY
HEAT CONDUCTIVITY
INTERNAL SLIP

Samples from either plant

MICA
WATER GROUND
HAYDEN MICA CO.
WILMINGTON, MASS.

Advertisers' Index

LAMINATES AND REINFORCED PLASTICS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 506.

CYLINDERS
Morart-Oxford Corp. 535

EXTRUDERS
Polygon Plastic Company 550

GYPSUM CEMENTS
United States Gypsum 530, 531

LAMINATES
Continental-Diamond Fibre, Div. The Budd Co., Inc. 541-544
Decar Plastics Corporation 550
Laminations, Inc. 540
National Vulcanized Fibre Co. 538, 539
New England Laminates Co., Inc. 550
Parkwood Laminates, Inc. 547
Richardson Company, The 546
Swedlow Plastics Company 532

LAMINATORS
Laminations, Inc. 540
National Vulcanized Fibre Co. 538, 539
Richardson Company, The 546

PAPERS
Hurlbut Paper Company 545
Morart Gravure Corp. 535
Wrenn Paper Company, The 551

PRE-IMPREGNATED MATERIALS
Fabricon Products, Div. Eagle-Picher Co. 549
Sandman, Eli, Co. 553
U. S. Polymeric Chemicals Inc. 553

PROCESSORS OF REINFORCED PLASTICS
Fabricon Products, Div. Eagle-Picher Co. 549
Hawley Products Company 529
Sandman, Eli, Co. 553
Structurlite Plastics Corporation 556

REINFORCING MATERIALS
Exeter Manufacturing Company 537
Glass Yarns & Deeside Fabrics Ltd. 534

RESINS
Allied Chemical & Dye Corp., Barrett Div. 552
United States Gypsum 530, 531

SANDWICH CONSTRUCTIONS, HONEYCOMBS
Douglas Aircraft Company, Inc., Aircomb Section 548
Hexcel Products, Inc. 528
Swedlow Plastics Company 532

Laminates and Laminating

By definition, laminated plastics "consist of superimposed layers of a synthetic resin-impregnated or -coated filler which have been bonded together, usually by means of heat and pressure, to form a single piece."

Laminates are generally divided into groups according to the pressures required to cure the resin or binder. The group of laminates made with resins requiring curing pressures over 1000 p.s.i. are generally termed "high-pressure laminates." Further subdivision of this group is made on the basis of filler, resin type, or end-use (e.g., phenolic-glass, silicone laminate, industrial laminate, decorative laminate, etc.). Most of these high-pressure laminates are used in such primary forms as sheets, rods, tubes, and cross-sections. More recently, molded forms have come into use.

The so-called "low-pressure laminates" were originally intended to cover those forms molded at pressures under 400 p.s.i. More recently, in the interests of production economies, higher pressures have started to be applied to the manufacture of these materials. The term "reinforced plastics" is generally used to describe such materials, although actually the term can be applied to any resin reinforced with any fiber, e.g., even fibrous glass-reinforced styrene.

HIGH-PRESSURE LAMINATES: GENERAL BACKGROUND

BY J. R. DUDLEY* and GLEN W. NEELY*

The technology involved in the manufacture and processing of high-pressure laminates is complex and requires extensive control facilities and well-trained technicians. Wide variations in properties are possible, and it is recommended that the design and processing engineer contemplating the use of laminates seek assistance from technical service representatives of those companies engaged in the production of laminates.

Materials: The selection of resins and reinforcements for the laminate is determined by the required characteristics sought in the end-product—and a wide variety of materials are available to meet these requirements. The most commonly used resins for high-pressure laminates are the phenolics, melamines, silicones, epoxies, and polyesters; most commonly used reinforcements are woven and nonwoven cotton, glass, asbestos, or synthetic fibers and kraft, alpha, and rag papers.

Saturation: Initial step in the manufacture of a high-pressure laminate is passing the reinforcing material through a bath of resin for impregnation. The amount of resin and degree of penetration will depend on the viscosity of the resin, temperatures used, time of immersion, permeability of the reinforcement, and the like. The setting of metering rolls, if used, can also have an important effect on the end-product. Squeeze rolls or doctor blades, for example, applied to the impregnated material after it has passed through the bath, can be adjusted to control the amount of resin remaining in and on the web. Roll coaters have also been used to meter resin onto the web.

After saturation, the material is conveyed through a horizontal or vertical drying chamber to reduce volatile content to the desired amount.

Sheets: In the manufacture of high-pressure laminate sheets, the saturated material is first cut to the required size. Sheets are then laid one on top of the other until a predetermined weight is reached. Thus, the laminator can control the thickness of the finished laminate after consolidating under heat and pressure.

By varying the type of materials

* Director of Research and Development and Sales Engineer, respectively, The Richardson Co., 2747 Lake St., Melrose Park, Ill.

Recent Developments and References were prepared by the editors.

Fibrous glass-reinforced polyester (*Hetron*) panels (*Fire-Snuf*, Resolite Corp.) have been approved by Factory Mutual, insurer of industrial buildings, for use in industrial construction. Tests showed that these panels would in no way contribute to flame spread throughout an industrial plant in the event of fire.

Outstanding electrical properties from power through radar frequencies and continuous heat resistance up to 250°C. are exhibited by a new Teflon (Du Pont) bonded glass cloth laminate (*Dilecto Grades GB-112T, GB-116T,* and *GB-12T,* Continental-Diamond Fibre Corp.). The laminate is recommended for microwave applications in both plain and copper foil-clad grades because of its extremely low dissipation factor.

Flame-retardant sheets and tubes in both paper-base and epoxy-glass cloth and polyester-glass mat sheets (Continental-Diamond Fibre Corp.) are available for panels, sub-panels, terminal strips, guards, spacers, television fly-back transformer panels, switchgear, and many other electronic equipment applications where flame-retardant properties are required along with good electrical and mechanical characteristics.

A flexible glass mat laminate (*Glastic Grade FM,* The Glastic Corp.) available in thicknesses of 1/32, 3/64, and 1/16 in. has formability and heat resistance not usually found in polyester laminates. In 1/32-in. thickness, this material will not lose dielectric strength after wrapping on a 3-in. diameter mandrel, nor after continuous exposure to 130°C.

A new cold-punching laminate (*Insurok XT-896,* The Richardson Co.) has low moisture absorption, low dielectric loss at high frequencies, and good insulation resistance. It punches clean at room temperature. In copper-clad form, the material has high bond strength and good blister resistance. Applications include mechanical assemblies and printed circuitry.

A paper-base phenolic laminate (*P-25,* Synthane Corp.) with good electrical properties and cold punching and cold shearing characteristics is recommended for copper-clad laminates used in printed circuitry.

An electrical grade phenolic laminate (*Phenolite E-2040,* National Vulcanized Fibre Co.) developed for radio and TV applications has good electrical properties and extremely low cold flow.

A line of polyester resin-glass mat laminates (*GP-9100, GP-9104,* and *GP-9202,* National Vulcanized Fibre Co.) have properties similar to the reinforced plastics used in sports car bodies, and offer dimensional stability and exceptionally high impact strength, combined with good arc resistance.

A new laminate for engraving (*Gravalum,* Hermes Plastics) has an ebony black phenolic center core bonded between two exterior layers of satin-finish aluminum. Engraving through the top layer exposes contrasting black lettering, eliminating the filling of engraving with paint. The laminate is masked on both sides for protection, and engraving is done through the masking material to avoid scratches.

An epoxy-impregnated translucent paper laminate (*Nelco-130,* New England Laminates Co.) is said to cold-punch to 1/16 in. without cracking, to absorb only 0.25% water after 24-hr. immersion, to be free of volatiles, and to have good dimensional stability.

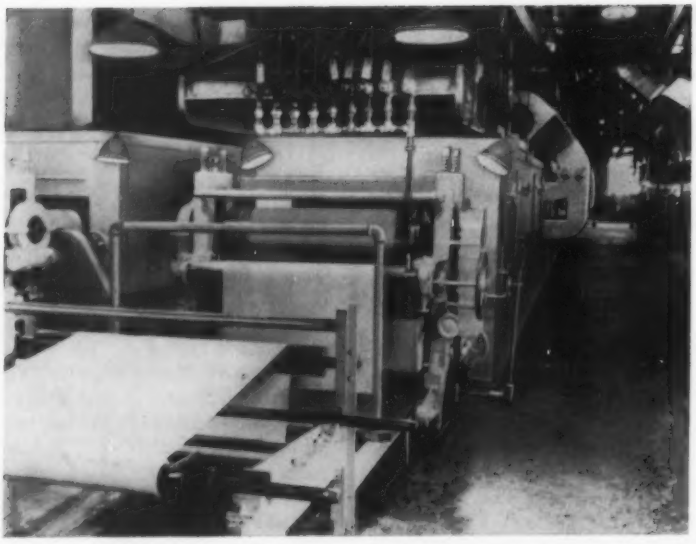
A fire-resistant, glass fabric-reinforced, polyester resin laminate (*Conolite A20SG1Y,* Continental Can Co., Inc.) was developed to replace aluminum and dope-coated Irish linen as wing and fuselage covering-material for small aircraft and has been approved by the C.A.A. for this application. It is produced by a unique, continuous process and therefore is available in rolls up to 150 ft. and cut-to-size sheets with a maximum width of 36 inches.

Fibrous glass-reinforced plastics panels (*Security Junior,* Resolite Corp.), featuring embedded aluminum or steel diamond mesh, offer unusual architectural design possibilities, as well as semi-transparent protection against flying particles and liquid spray. The panels have high impact resistance because of the metal mesh reinforcement. They have light transmission values ranging from 71% (clear) to 15% (coral), the average being 50 percent.

Flat translucent sheets of reinforced plastics (*Glazor,* Strick Plastics Corp.) press molded from 3-oz. glass mat and polyester resin are available in sizes ranging from standard sash to 48 by 96 inches. The manufacturer states that this material will support 100 lb./sq. ft. on a 4-ft. span and that it can be made flame-resistant by the use of self-extinguishing resin. It is suggested for use in skylights, greenhouses, sidewalls, shower stalls, etc. This company also makes a corrugated sheet reinforced with 2-oz. mat (*Daycor*).

An adhesive (*Adhesive No. 156-2,* Flex Craft Industries) for glass-reinforced polyester sheeting can be used to bind the reinforced sheet to itself or to paper, metal, wood, fabrics, or to other plastics. Applied by conventional roller coater, spraying, or brush, the adhesive is of a medium viscosity and dries quickly.

Decorative fibrous glass-reinforced polyester laminates (*Tropiglas,* Russell Reinforced Plastics Corp.) now supplement a line of structural-grade polyester-glass laminates. The decorative laminates are available in single-wall and sandwich-type construction and are listed under the trade names of Cathedral Tropiglas, Woodcurl Tropiglas, Chromacel Tropiglas, and Mosaic Tropiglas.



Coating machine for paper used in laminates is designed to provide close control over amount of resin with which paper is impregnated. (Photo, J. O. Ross)

used in the lay-up, a wide range of sheets with varying characteristics can be turned out. Sheets can be made up entirely of one type of saturated material or of the same material with varying degrees of saturation or even of different combinations of materials. For example, a sheet may be composed of kraft paper of one saturation for the core and a kraft paper with a different saturation for the surface sheets, or it may have a kraft paper core and a fabric surface sheet, and so on.

Pressing of the sheets is done between heated platens (generally in a vertical-acting, multi-opening unit) under carefully controlled temperature, pressure, and time cycles.

Rolled tubes: Rolled tubes are manufactured by convolutely winding the saturated material around a polished mandrel and then cradling the material between heated rollers and a pressure roll. The saturated material should be under tension.

After a sufficient amount of material is wound on the mandrel, the assembly is cured in an oven to complete consolidation. The mandrel is then withdrawn and the tube is centerless ground or machined to desired diameter.

Molded tubes: Molded tubes are produced by convolutely winding saturated material around a mandrel and molding the combination in a heated, split-type mold. The mold is designed to cut or pinch off the excess material that protrudes along the side closures as the two members are brought together under pressure to size the outside diameter. The mandrel which sizes the inside diameter cannot be anchored. Therefore, the wall thickness is subject to more variation than in the case of rolled tubes. The tube is then centerless ground to desired size.

Since molded tubes are cured under heat and pressure, their characteristic values approach or are equal to laminated sheets. Molded tubes of relatively thin walls will have less strength on each side where the saturated material is pinched off as the mold closes.

Rods: Rods are produced by molding or by centerless grinding square strips cut from sheet materials. The molding process is identical to the molding of tubes except that a mandrel of minimum size is used for winding the material and is removed before placing the wound preform into the mold. The molded rod is then centerless ground to desired size.

Molded laminates: Parts produced by molding laminated materials are beginning to receive more consideration by design engineers. By proper saturation, preforming, and tailoring of the reinforcing materials, parts can be produced having strength characteristics many times greater than conventional molding compounds. By proper design and positioning of the saturated material in the mold, parts can also be produced having greater strength than identical parts fabricated from flat laminates.

One technique for molding laminates is to place small squares of impregnated filler materials into a mold of the required design and then curing by the application of heat and pressure. Cut strips of filler materials placed in layers in the mold can also be used.

Applications: In addition to those laminates produced for specific applications, a wide range of standard laminates are available to the design engineer (see Table I, p. 509).

The laminates have much to offer. Their high strength (on the basis of strength-weight ratio, laminated materials are among the strongest known) makes them suitable for many aircraft, structural, and other key industrial applications. Strength, moisture resistance, and good electrical properties make them a volume material in the electrical industry. Gears machined from laminates also find volume markets by virtue of their high strength, good wearing qualities, and ease of machinability. Printed circuits based on laminate bases hold great interest in present-day electronics design (see p. 511). The use of silicones and high-temperature phenolics has resulted in laminates that can operate at higher levels of temperature than were previously possible. Epoxy resins have contributed to certain improvements in electrical characteristic values, and recent resin combinations have improved strength, machinability, and stability of mechanical grades. With additions of graphite and molybdenum disulfide, separately or in combination, the coefficient of friction has been reduced for bearing applications. The use of polyester or similar resins as binders for such inorganic reinforcements as glass or asbestos fibers has improved the chemical

TABLE I: Properties and applications of industrial NEMA grade laminates[1]

NEMA grade	Typical properties	Typical applications
X	Paper phenolic. General-purpose grade, high strength, low cost.	Panels, contactors, terminal blocks, insulating washers.
P	Paper phenolic. Punch grade, not as strong as X. Low cost.	Spacers, switch links, and miscellaneous small punched parts.
PC	Paper phenolic. Similar to P but recommended for punching at ambient temperatures. Lower strength and greater cold flow than P.	Same applications as P except for limitation of strength and cold flow.
XX	Paper phenolic with better electrical properties than X or P.	Miscellaneous parts for communication equipment, switchboard panels, and exposed parts.
XXP	Paper phenolic better than XX in electrical properties and humidity resistance. Can be punched hot. High strength.	Relays, vibrators, tube sockets, communication equipment.
XXX	Paper phenolic. Suitable for high-frequency, low-loss application in high humidity.	Radio, radar, and television, high-voltage parts. Printed circuits.
XXXP	Best paper phenolic electrical grade. Highest dielectric strength and lowest dissipation factor. Can be punched hot (some manufacturers now offer a special XXXP grade that can be punched cold).	Punched parts for critical electrical application. High-voltage and high-frequency uses. Printed circuits.
ES-1	Paper base engraving stock. Core and face of contrasting color.	For engraved nameplates.
ES-2	Similar to ES-1 except for color.	For engraved nameplates.
ES-3	Similar to ES-1 except for color.	For engraved nameplates.
C	Cotton fabric phenolic. Cloth heavier than 4 oz./sq. yd. Not recommended for electrical uses. High impact strength.	Mechanical application gears and bearings, rayon spinning buckets, miscellaneous disks, pistons, and rings for pumps and valves.
CE	Similar to C but with controlled electrical properties. Better in humidity; not for high-voltage primary insulation. Better for machining than grade C.	Bus bars, panel boards, slot wedges. Many applications same as C.
L	Cotton phenolic with fabric less than 4 oz./sq. yd. Called linen grade by the trade. Better machining than C and CE. Lower impact strength than C. Not an electrical grade.	Mechanical parts for pumps, valves, clutches, etc. Small gears and bearings.
LE	Similar to L but with better moisture resistance and controlled electrical properties. Not as good electrically as paper-base laminates. Not for high-voltage primary insulation.	Small parts, both mechanical and electrical, that require good punching and machining qualities.
MC	Melamine laminate reinforced with cloth similar to C grade. Excellent arc resistance and better resistance to alkali than phenolic laminates. Between C and CE in moisture absorption.	Electrical uses requiring arc resistance. High-voltage switchgear and terminals.
A	Asbestos paper phenolic. Better heat and flame resistance than cellulose paper phenolic. Not recommended for primary insulation at over 250 v. Difficult to machine. Very low moisture absorption. Very low cold flow.	Low-voltage, electrical application in electric welders, traction motors, etc.
AA	Asbestos cloth phenolic. Properties similar to A but better strength.	Often molded into shapes for collector rings, commutator parts, and armature wedges.
G-2	Staple fibrous glass cloth, phenolic binder. Excellent electrical properties under high humidity. Very low dielectric losses.	Electronic equipment.
G-3	Continuous filament glass cloth-phenolic laminate. High strength except bond strength is poor. Good dimensional stability at elevated temperatures.	Electronic equipment.
G-5	Continuous filament glass cloth-melamine laminate. Second only to silicone laminates in arc and heat resistance. Best in flame resistance.	Electronic equipment. Printed circuits for high voltage.
G-6	Stable fibrous glass cloth with silicone resin binder. Superior dielectric loss and insulation resistance properties. Good heat and arc resistance. Meets AIEE requirements for Class H insulation.	Electronic application requiring Class H material or very low dielectric loss.
G-7	Continuous filament glass cloth with silicone binder. Similar to G-6 except flexural strength is higher and bonding strength is lower.	Similar to G-6.
G-10	Continuous filament glass cloth with epoxy resin binder. Extremely high flexural impact and bonding strength. Superior electrical qualities in humidity.	High-frequency electronic parts. Printed circuits for military applications.
N-1	Nylon cloth base with phenolic binder. Excellent electrical properties in high humidity. Good impact strength, low modulus. Easy to punch. Subject to flow at elevated temperatures.	Specified by MIL-P-15047 for certain military applications.
CF	Cloth phenolic similar to C grade except that it can be formed into simple shapes when heated. Called postforming grade.	Used to form angles, channels, and other simple shapes. Not recommended for high-voltage electrical applications.
GPO-1	Random fibrous glass mat bonded with polyester resin. A low-pressure laminate. Can be made flame retardant. Good arc and heat resistance.	Mechanical and electrical uses. Excellent for structural applications requiring an insulating material.

To choose a laminate for a particular application, reference should be made to the standards publication of the National Electrical Manufacturers Association, 155 E. 44 St., New York 17, N. Y., or to the catalogue information supplied by one of its members. In most cases, catalogue information is to be preferred because manufacturers often have more than one grade corresponding to a given NEMA classification.

[1] Prepared by Laminated and Insulating Products Dept., General Electric Co.

resistance of laminates. There has also been considerable improvement in the decorative laminates field, resulting in more faithful reproduction of wood grains and colors and greater mar resistance. A more detailed discussion of these various types of special-grade plastics is offered in the article below.

HIGH-PRESSURE LAMINATES: SPECIAL GRADES

BY F. WILLIAM JAHNS, JR.*

Most of the specialized laminates involve the use of the newer resins, e.g., silicones, epoxies, etc., or combinations of several different types of core or facing materials. It is these that will be discussed in this chapter, together with some of the more important specialized markets such as missiles and printed circuits.

Combination laminates

In many cases, it is desirable to use combination laminates in which the facing is different from the core of the build-up. Typical examples are: a phenolic core with a vulcanized fibre facing designed to impart arc resistance to the facing; arc-resistant fuse tubing with a vulcanized fibre core to provide arc quenching and with a paper or epoxy-glass overwrap to offer high mechanical strength; various types of metal bars with a paper-base phenolic laminate or other covering to provide insulation; and various combinations of phenolic laminate cores surfaced with natural or synthetic rubber, and, in some instances, with cork to act as a seal on the tops of electrolytic condensers.

For many years, metal tubes have been covered with phenolic laminates for use as conveyor rolls in metal processing operations. It is also possible to use conductive inserts, such as aluminum or copper foils, in the make-up of paper-base phenolic or other types of laminates. In this instance, the conductive inserts provide a means of ground connection and also increase the corona resistance due to better distribution of the electrical stress.

Various types of synthetic fiber surfaces on a core of glass base polyester laminates are used in increasing the chemical resistance and providing lower abrasive qualities than are exhibited by the conventional glass-polyester laminate without such a synthetic fiber covering.

Established applications for a metal tube with a fabric-base phenolic covering exist in aircraft landing gear equipment and hydraulic pistons.

With the advent of cementable Teflon[1], it is now entirely feasible to apply a Teflon surface, either in the unsupported or glass-supported form, to such materials as paper-base phenolic laminates or glass-base epoxy laminates for electrical insulating or low coefficient of friction properties.

Glass-Teflon laminates

Glass-base Teflon laminates, which have outstanding electrical properties, have found market outlets in critical military items and, in some instances, applications in areas where corrosive atmospheres would deteriorate other types of laminates. Among its advantages are outstanding heat resistance and the retention of low-loss electrical properties over the complete frequency range usually encountered. The importance of this glass-base Teflon laminate for military use is indicated by the recent issuance of a military specification covering this product.

Epoxy laminates

Some of the more important properties responsible for the increasing acceptance of epoxy laminates in many fields are: low dimensional change, fungus resistance, minimum gassing, high mechanical strength, Class B temperature use (325 to 350° F.), superior bond strength, low water absorption, and compatibility with epoxy potting compounds used for encapsulation.

In addition to the above properties, glass-base epoxy tubes, both plain and when combined with a vulcanized fibre liner, have exceptionally high bursting strength. This feature has caught the attention of many manufac-

* Technical Sales Service Supervisor, Continental-Diamond Fibre Corp., Div. of The Budd Co., Newark 29, Del.

[1] Trademark of E. I. du Pont de Nemours & Co., Inc.

Typical industrial application for fabric-base phenolic high-pressure laminates is magnet winding core boxes. The three-stage machining operation by which the core boxes are made is conducted on the completely automatic screw machine illustrated below. (Photo, Continental-Diamond Fibre Corp.)



Laminated sheets: equivalent military and NEMA grades

Military spec. and type	*NEMA grade*	*Filler*	*Resin*
MIL-P-78A, Type HSP	P	Paper	Phenolic
MIL-P-78A, Type NDP	ES-1	Paper	Melamine (core)
	ES-2		Phenolic (surface)
MIL-P-997B, Type GSG	G-7	Glass fabric	Silicone
MIL-P-997B, Type GSG	G-6	Glass fabric	Silicone
MIL-P-3115B, Type PBG	XX	Paper	Phenolic
MIL-P-3115B, Type PBE	XXX	Paper	Phenolic
MIL-P-3115B, Type PBE-P	XXXP	Paper	Phenolic
MIL-P-3115B, Type PBE-P	XXXP	Paper	Phenolic
MIL-P-8059	A	Asbestos paper	Phenolic
MIL-P-8059	AA	Asbestos fabric	Phenolic
MIL-P-8655A, Type Postforming	CF	Cotton fabric	Phenolic
MIL-P-15035, Type FBG	CE	Cotton fabric	Phenolic
MIL-P-15035B, Type FBM	C	Cotton fabric	Phenolic
MIL-P-15035B, Type FBE	LE	Cotton fabric	Phenolic
MIL-P-15035B, Type FBI	L	Cotton fabric	Phenolic
MIL-P-15037B, Type GMG	G-5	Glass fabric	Melamine
MIL-P-15047B, Type NPG	N-1	Nylon fabric	Phenolic
MIL-P-17721C, Type GMM	G-8	Glass mat	Melamine
MIL-P-18177A, Type GEE	G-10	Glass fabric	Epoxy
MIL-P-18324A, Type B		Cotton fabric	Phenolic
MIL-P-19161, Type GTE	None	Glass fabric	Teflon[1]

[1] Trademark of E. I. du Pont de Nemours & Co., Inc.

turers, especially those engaged in the production of high-voltage fuses.

Silicone laminates

Glass-base silicone laminates are now widely used as an insulating medium in electric motors, generators, and transformers. These laminates have been responsible for a substantial increase in power output for a given size unit of electrical power equipment. They combine better heat resistance, as compared to phenolic grades, plus arc resistance, low moisture absorption, and good electrical properties which are retained under humid conditions and after prolonged exposure to high temperatures.

Some of the better-known applications of silicone laminates are in deicing units and radar equipment.

Laminates in missiles

Reliability is a key reason behind the use of laminates in missile applications. As an illustration, it is pointed out that in guided missiles using only 100 components, each of these can fail only once in 1000 times if the missile is to have a 90% reliability. In actual practice, however, missiles use many more than 100 components, thereby making reliability even more important.

The usual applications of laminates in missiles include fins and guidance and control systems. Appreciable quantities of glass-base polyester, epoxy, silicone, Teflon, and phenolic laminates are used in these applications. In missile components where higher reliability and superior performance are of paramount concern, the relatively high cost is warranted.

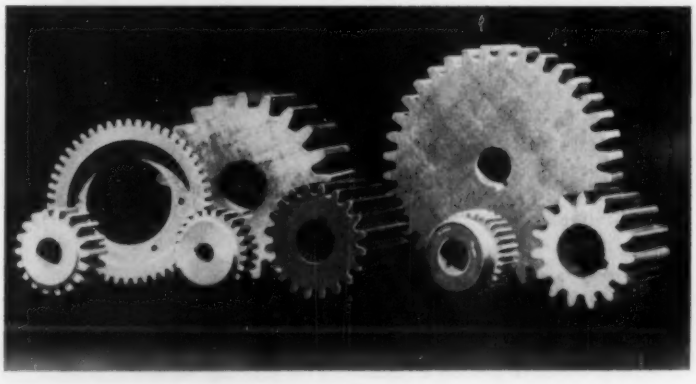
The guidance systems of missiles usually represent about 50% of the entire cost of the missile, although those systems constitute only 5 to 10% of the total weight. The use of glass-base epoxy copper-clad laminates in printed circuits designed for missiles contributes to miniaturization.

Printed circuits

Manufacture: There are a number of methods by which printed circuits can be produced. Metal foil may be applied to either one or both surfaces of a base laminate. When copper foil is used, either electrolytic or rolled copper may be applied.

A common method is to apply

Gears, characterized by high mechanical strength, long wear, and silent action, are cut from a phenolic-canvas base stock. (Photo, Continental-Diamond)



a thin sheet of metal (usually copper) to one surface of a base laminate. For most industrial uses, a NEMA XXXP grade (paper-base phenolic type) is employed as the base. For certain applications, a NEMA G-10 (glass-fabric-base epoxy) grade is desirable. Many other base laminates are also used.

The desired pattern is then applied to the copper surface, usually by printing or silk screening, using an acid resist. After further processing, the metal-clad laminate is placed into an etching solution to remove that portion of the copper which has not been given an acid resist treatment. The acid resist is then removed by solvents.

The prepared board is completed by punching holes for insertion of the leads of component parts such as condensers, resistors, tubes, transistors, and sockets to the side of the panel opposite the printed circuit pattern. For large-quantity runs, the components are usually inserted by automation processes.

As the final step, the side of the panel on which the circuit has been printed is subjected to a solder bath.

Many copper-clad laminates may be cold punched. To enable a visual check on register, these are available with translucent properties.

When some severe service conditions are involved, printed circuit boards are plated with metals, such as gold, nickel, rhodium, lead-tin, chrome, and tin. In processing printed circuits, modern equipment, such as Wiedemann "printed circuit" turret punch presses and Zagar multiple drilling heads, is used.

There are a number of printing techniques used, and each differs significantly in its adaptability and usefulness for automation processes.

Advantages and uses: Printed circuits in various forms are going into an ever-increasing number of applications.

Some of the more important advantages responsible for their wide acceptance are: 1) unit construction of component parts and assemblies; 2) greater simplicity of wiring; 3) each printed circuit



Paper used in manufacture of decorative laminate is coated with melamine resin. As paper slides out of trough (above), it is dried in vertical tower. (Photo, American Cyanamid)

is identical, with the result that there are no wiring errors; 4) faster production; 5) less floor space is required for manufacturing areas; 6) lower manufacturing costs are possible due to faster production; 7) lower rejects; 8) savings in material costs and overhead; and 9) component assemblies, subassemblies, or individual terminal boards may be solder dipped, which permits the soldering of many joints in one operation.

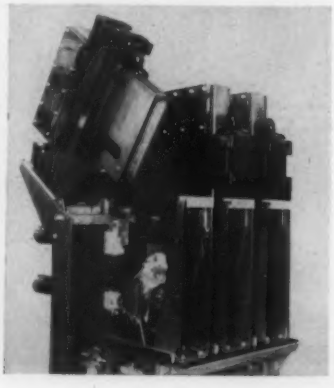
Some of the more important applications of printed circuits are: hearing aids, small portable receivers, telephone terminal boards, radio and television receivers, missiles, ground missile controls, analog and digital computers, radar equipment, telemetering equipment, switches and code disks, tape recorders and dictaphones, microphones (small lipstick type), business machines, and toll road counters.

There is an increasing interest in the flexible type of printed circuits. These flexible circuits are usually manufactured from thin sheets of such base materials as copper-clad glass-base epoxy laminates and copper-clad glass-base Teflon laminates. The thicknesses normally range from 0.010 to 0.015 inch.

One special type of copper-clad laminate uses a thin vulcanized fibre core. It is used as a spark condenser in automobile radios. In this application the copper foil is not etched.

A relatively new use for printed circuits in the communication field is in rural carrier telephone circuits.

Air magnetic circuit breaker contains many postformed and molded paper-base phenolic laminates. The arc chute shells are fabricated of flame-resistant laminates. (Photo, I-T-E)



Other developments

Laminates impregnated with new high-temperature laminating resins have high initial strength which is retained to a remarkable degree after exposure to high temperatures. Compressor blades of jet aircraft engines are a typical application.

To provide added safety to equipment where laminates provide the electrical insulation, there have been developed a number of grades with flame retardant properties. These include various types of paper-base phenolic laminates, glass-base epoxy laminates, and glass-mat polyester laminates. In some instances, it is possible to provide this flame-retardant quality in postforming grades of laminates.

By using different variations of established laminating techniques, decorative thermoformable styrene sheets are being produced by laminating reverse-printed overlays to the surface of the sheet.

Finally, it is of interest to laminators to note that the radio-electronics-television industry

which uses numerous types of laminates experienced a growth of approximately 15% in 1956. This expansion places it in the category of one of this country's outstanding growth industries and fifth in size in dollar value of goods shipped—making it a big and important market for laminate material.

REINFORCED PLASTICS

All laminated structures molded in their final form, whether sheet, rod, tube, or contoured part, at pressures under 400 p.s.i. are called low-pressure laminates. This category can include items made at "contact" pressure or at no greater pressure than that exerted by the weight of the individual layers of the laminate. Low-pressure laminates, generally fibrous glass-reinforced polyester laminates, are usually included under the over-all heading of "reinforced plastics." The term also includes those laminates made by matched metal molding processes in which pressure higher than 400 p.s.i. is used, and more recently, the description "reinforced plastics" has been extended to further include premix molding compounds that can be molded by conventional compression molding techniques.

Actually, any combination of moldable plastics material and sheet or fibrous reinforcement is a "reinforced plastic," but the term is usually used to imply a "fibrous glass-reinforced plastic."

Polyesters are the most common laminating resins used in this area because of their relatively low cost, ease of handling, and generally satisfactory performance. Epoxy resins produce stronger laminates, but are more expensive. However, they have been growing in popularity, particularly in the manufacture of parts for transportation applications where strength and light weight are important. Phenolic, silicone, special polyester formulations, and special formulations of phenolic and epoxy resins impart improved high-temperature properties, but are more difficult to process. And in each of these groups, literally hundreds of variations are available, tailored to meet the special needs of the fabricator.

According to the Society of the Plastics Industry, close to 140 million lb. of reinforced plastics were consumed in 1956, a 30% gain in sales over 1955. Of this amount, resins accounted for about ½ of the total. Polyester resins led the parade with total sales of about 65 million lb.; the remaining 5 million lb. was divided between the fast-rising epoxy resins (with estimated sales of about 4 million lb.), low-pressure phenolic, polystyrene, silicones, melamine, and vinyl.

The markets into which reinforced plastics are going are many and varied. One of the fastest growing seems to be the field of transportation. It is estimated that aircraft uses about 20% of the total poundage of reinforced plastics, with the boat industry accounting for about 16 percent. A considerable amount also goes into the automotive and truck industry in the form of structural and body parts, as well as accessories, e.g., heater and air conditioner housings molded of premix materials. Reinforced plastics have also found important outlets in the construction field, for tooling, for pipes, and for such consumer products as sleds, fishing rods, luggage, automobile bodies and component parts, etc.

References

Consult the Subject Index for additional information on laminates and laminating. See also the Laminates Chart and the Low-Pressure Laminating Resins Chart for information on properties and trade designations. For sources of laminates and laminating resins and equipment, see Directory Index, p. 1018.

"Printed circuit parts kit," MODERN PLASTICS *34*, 214 (Nov. 1956).

"Big boat—no mold," MODERN PLASTICS *33*, 104 (Mar. 1956).

"The manufacture of laminated plastics by automatic control," by W. A. Goldstein, Plastics (London) *21*, 221 (Sept. 1956).

"Resins for reinforced plastics," by E. Schlieben, Product Eng. *27*, 198 (May 1956).

"Toughening up reinforced resins," Chem. Eng. News *34*, 2586 (May 21, 1956).

"Shock-curing of some laminated materials," by C. A. Redfarn and J. Bedford, Brit. Plastics *29*, 171 (May 1956).

"Flexible/rigid laminates in chemical plant," Brit. Plastics *29*, 52 (Feb. 1956).

Ceremonial Elk's head is molded of polyester resin-fibrous glass laminate using hand lay-up technique. Finished head weighs 7 lb.; bronze counterpart weighs 24 pounds. (Photo, Bigelow Fiber Glass and Mountain Ash Fiberglass)



Machining Laminates

BY GEORGE A. EBELHARE*

Laminated plastics—whether in the form of sheets, rods, or tubes —are readily and easily machined on standard metal and woodworking machinery. Because these materials have many fundamental properties not common to metals, they are often considerably easier to machine than metals—with the exception of glass-base laminates, which require special techniques. With this one exception, laminated plastics have lower shearing strength, permitting the use of high cutting speeds and feeds even on machines of light construction. These same properties, however, necessitate certain modifications of metal fabricating practices before they can be adopted to the machining of laminates. The properties which affect machinery techniques are as follows:

1) Laminated plastics are poor conductors of heat. This makes it necessary to cut down the amount of heat generated. Care must be taken to see that tools are properly ground and chips are removed from cutting points.

2) Being more resilient than metals, laminates require greater clearance and less rake on cutting tools.

3) Being softer than steel, laminates require tools that can remove chips faster than the tools used in machining metal.

4) Because of the laminated structure, certain machining operations such as drilling parallel with the laminations, or milling at right angles to them, will require additional care.

5) The laminated structure is less homogeneous than metal, making it necessary to provide backing-up plates in many operations.

6) In all machining operations on laminates, it is extremely important to keep tools sharp. For glass-base laminates, diamond- or tungsten-carbide-tipped tools are necessary. Because of the heat generated in these cases, both tool and work must be flooded in a stream of coolant, or a special corrosion-inhibiting mist lubricant can be applied to the work with compressed air.

* Fabricating Gen. Mgr., Synthane Corp., Montgomery Ave., Oaks, Pa.

References were prepared by the editors.

Shearing

Most laminates may be cut by shearing with metal shears of the rotary or guillotine type (see Fig. 1, right). Up to 1/16-in. thickness in some paper-base materials and up to 1/8-in. thickness in most fabric-base grades may be sheared at room temperature (minimum of 50° F.). Harder grades, including asbestos, graphite, and glass, can be sheared after heating from 200 to 250° F. (depending upon grade and thickness). With hand feeding, speed of cutting may be up to 50 strokes/min. for guillotine shearing or 600 ft./min. for rotary shearing.

Guillotine shears can also be used for angular cutting in addition to straight stripping.

When shearing grades and thicknesses that require heating, it is necessary to heat the material uniformly and to remove it from the heating medium as soon as it reaches the required temperature.

Sawing

Band-sawing: The standard woodworking band-saw may be used on laminated plastics. For most grades, the saw blades should be file-hard carbon steel; for glass, asbestos, and all other hard grades, blades should be hardened steel with soft hacks. Teeth range from 5 to 8 points/in.; and cutting speeds up to 9000 surface ft./minute.

Band-sawing is not recommended for straight cuts on material which is thin enough to be cut with a circular saw. It is recommended for curved or straight cuts on material up to 10 in. thick where smooth edges and close tolerances are not required. Blades must be kept sharp at all times.

Circular sawing: For dry sawing, the floor or bench circular sawing machines that are standard in the woodworking industry can be used. For wet sawing, machines equipped for water operation are required. For most grades, hollow-ground saws of carbon steel are recommended. The teeth should have no set and blades should be 1/16 to 1/8 in. thick with 4 to 8 teeth/in., depending on thickness and form of material. For hard grades, carbide, diamond, or abrasive saws should be used.

Laminates up to 1 in. in thickness can be sawed dry where smooth edge and close tolerance are required. Thicknesses up to 4 in. can be sawed wet, provided special equipment and care are used. Cutting speeds range up to 13,000 surface ft./min., either hand- or power-fed.

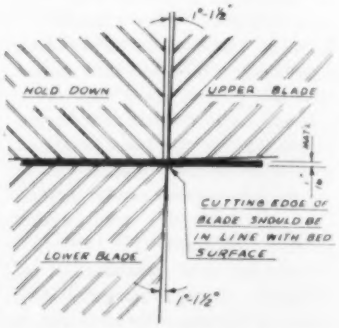


Fig. 1: Cross-section of metal squaring guillotine shears used for cutting laminates. Relative position of blades and hold-down are shown

Small tubing may be cut by feeding the material straight through the saw. Heavy-walled tubing over ¾ in. in diameter should be "rolled" through the saw to prevent excessive breakout.

A special long-length circular saw to cut sheets up to 38 in. wide and 25 ft. long has been developed by one company. Equipped with diamond or abrasive cut-off wheels, tungsten-carbide-tipped

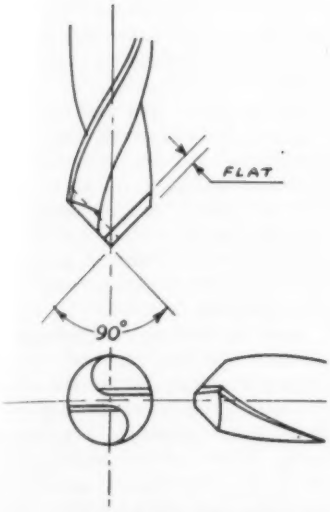


Fig. 2: Drills should be especially designed for work on plastics laminates. They should have high helix angles and wide flutes

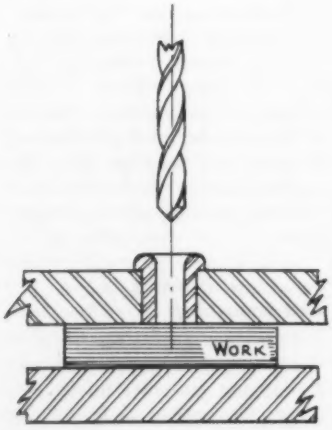


Fig. 3: Drill jig must be accurately located so drill does not strike bushing

wheels, or high-carbon steel saws, depending on the material to be cut, the new saw permits the production of planer-smooth cuts on materials up to 4 in. thick.

Drilling

Drills especially designed for use on laminated plastics are now available (see Fig. 2, above). These drills are made of high-speed steel and have wide, highly polished flutes with a high helix angle. Carbide-tipped drills should be used for hard grades.

Since the material shrinks somewhat after the drill is removed, it is necessary to drill holes 0.002 to 0.004 in. oversize or to ream the hole to the size required. The use of well-designed drill jigs in which the work is clamped between top and bottom plates (see Fig. 3, left) will insure an accurate and clean job. When top and bottom plates are not used, all holes should be backed with a piece of wood or plastic to prevent break-out and to insure a clean, sharp hole.

Drilling parallel with the laminations should be avoided whereever possible. If drilling must be done in this manner, the work should be held in clamps or a drill jig.

Drills should be kept perfectly sharp. Frequent backing of the drill from the hole will aid in removing the chips and decrease the heat produced.

Most laminates are drilled best without lubricant. In drilling glass-base grades, however, the work should be flooded with water coolant or with special corrosion-inhibiting mist sprays to decrease both dust and heat. Recommended drilling speed is 400 surface ft./minute.

The tolerances on drilled holes will vary with the diameter of the hole and grade of material. With proper care, tolerances as close as ±0.001 in. are obtainable.

Tapping

Tapping procedure has been standardized for all types of materials. A ground, high-speed steel tap is recommended. This tap has 3 flutes and for use with all laminates should be 0.003 to 0.005 in. oversize (see Fig. 4, right). Drill sizes should be selected so as to leave approximately 75% of full threads. Class 2 fits are practical in laminated plastics. No lubricant is needed under normal conditions.

Flycutting

Flycutting is generally employed to cut disks or large holes not practical for drilling. Tools are designed so that the center post holding the cutter bar can be used as a pilot in a previously drilled hole to steady the bar during the cutting operation. Cutting tools must have clearance both in front and inside of the cutting edge. Recommended cutting speeds are from 300 to 400 ft./minute.

All laminates can be countersunk or counterbored. The cutter should carry a negative rake of from 0 to 10°, and cutting speeds should be approximately half those used in drilling. Initial contact with work should be light in order to cut the highly polished surface without cracking it. If chattering occurs, a slower speed may correct this condition.

Milling

All laminated phenolic materials can be milled, using standard milling cutters. (See Fig. 5, below). For longer life between sharpenings, however, carbide-tipped cutters are recommended. Cutting speeds given below are based on carbide-tipped cutters and should be reduced approximately 25% for high-speed steel cutters.

For most grades, cutting speeds of 800 to 1000 surface ft./min. are satisfactory. For glass and asbestos, speeds should be reduced by about half. Feeds may

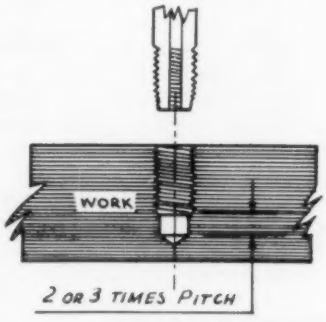


Fig. 4: High-speed steel taps with three flutes are recommended for laminates. Note depth of drilled hole

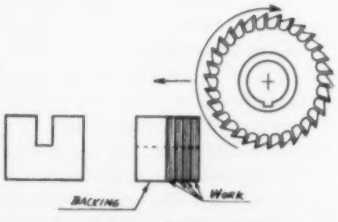


Fig. 5: Backing support during milling prevents delamination problems in the laminate

be up to 20 in./min. depending on the finish required. For fabric cotton-base materials, best results are obtained by operating at the highest spindle speed the cutter will stand, with the maximum possible feed, to give desired finish. Almost all types of milling should be done by the "climb method" (see Fig. 6, right) to prevent the edges of the material from being raised, to hold the work tightly in the fixture, and to clean the chips from in front of the cut. When cutting across the laminations, backing plates of hard wood or other suitable materials are recommended. Coolant should be used when cutting the hard materials.

Because of their generally greater ease of machining, as compared with metals, laminates are ideally suited to be worked on by air-actuated fixtures and holding devices.

Gear cutting

Gears with any of the standard types of teeth may be cut from plastics laminates. Tubing or rods are never used. Teeth may be formed in blanks by hobbing, shaping, or milling, using standard metal gear-cutting machines. The highest speed and feed of the machine should be used. Special gearing may be installed to increase surface speed and feed mechanism to rates greater than those commonly employed for cutting metal.

In cutting teeth in laminated gear stock, the last blank must be backed up to prevent fraying and break-through.

Screw machines and turret lathes

Hand-operated and automatic screw machines are highly productive in machining laminated plastics, and operate the same as for brass, except at much higher speeds and feeds. Production from these machines ranges from 1000/hr. down, depending on the job requirements.

Laminated phenolic cams are economically used on automatic screw machines where tool pressures are not too great. Speeds range up to 3000 r.p.m. for hand-operated screw machines and up to 7000 r.p.m. for automatic machines. Any desired feed can be used, depending on the finish required.

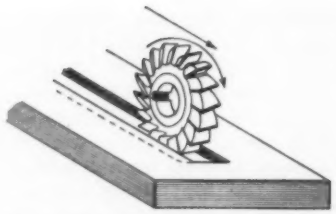


Fig. 6: Climb milling also prevents delamination. Standard cutters may be used

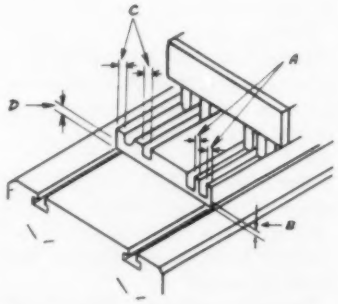


Fig. 7: Examples A and B show poor design, not enough material remains; at C and D ample material remains

Turret lathes are operated at their top speeds for most jobs within their capacity. The operations are approximately the same as those used for working with brass, except that much higher speeds and feeds are involved. High-speed steel and carbide-tipped tools are used, ground approximately the same as for brass, with spindle speeds up to 1500 r.p.m. and peripheral speeds up to 3000 surface ft./minute.

Most screw-machine and turret-lathe work is performed dry, but for deep-hole drilling, threading, etc., a coolant should be used. Forming and undercutting can be performed successfully, but care must be taken to use an extremely fine feed, preferably not over 0.0005 in. to 0.001 in./revolution. Many attachments, fixtures, and magazine feeds can be employed.

Lathe operations

Engine lathes or production lathes are generally used. Turning, boring, recessing, and any other lathe operations can be done successfully. For internal threading, and when cutting the hard materials, it is advisable to use lubricant or coolant.

Speeds up to 3000 surface ft./min. can be used, with any desired feed, depending on finish required. High-speed, carbide- or diamond-tipped tools are used for turning, boring, facing, and cutting-off. Tools should be ground from 0 to 10° negative rake for threading and forming.

Lathe operations on laminated plastics are approximately the same as for brass, except that the surface speed can be higher. Fabric-base materials can generally be worked with high-speed steel, but for paper, graphite, asbestos, and glass, carbide- or diamond-tipped tools should be employed whenever possible.

Planing and shaping

All grades of laminated plastics can be shaped and planed, using standard metal-working planers and shapers, but care must be taken to prevent weakening (see Fig. 7, left). When cutting across the laminations, the end of the cut should be backed up to secure a clean edge. This precaution is not necessary when planing parallel to the laminations.

Punching, shaving, and broaching

Punching: Sheets up to 1/16 in. thick in some paper-base materials and up to 1/8 in. thick in most fabric grades can be punched cold (minimum of 50° F.). Glass-base grades can be punched cold in thicknesses up to 1/8 inch. All other materials must be heated before punching, using hot plate, oven, hot oil, or infra-red lamps. The degree of heat to be used depends entirely on the thickness and grade of material. In most cases 120° F. is high enough, although occasionally temperatures as high as 250° F. are required.

Laminates cannot be punched to extremely close tolerances because of the normal contraction of the material and because of its thermal contraction when punched hot. Satisfactory holes are difficult to punch if the distance between hole or between holes and edge of material is less

than 1.5 times the thickness of the material. (For the best punching designs, see Fig. 8, below.)

Shrinkage allowances must be taken into consideration when designing tools. In punching 1/16-in.-thick laminate material, piercing punches should be 0.002 in. over drawing dimension. Sides must be smooth, straight, and free from annular grooves or tool or grinding marks. Die and stripper clearance should be 0.001 in. on a side. Close stripper clearance is necessary to prevent delamination when piercing punch is withdrawn from hole. Approximate shrink allowance should be 0.002-in./inch.

Progressive, compound, and multiple operating dies, including combination blanking and shaving dies, are used. Dies are practically the same as those for metal except that little clearance is allowed between punch and die and punch and stripper plate. Carbide dies should be used for glass if the quantity involved permits the additional expense that has to be undergone.

Manual or mechanical feed, with automatic stops and gages, can be used. When practical, rotary-table feeding mechanism with vacuum or mechanical pick-up may be employed.

Shaving: When smoother edges than can be had by punching are required, a shaving operation can generally be used. For irregularly shaped blanks too thick to punch, shaving will give the desired shape accurately and rapidly. Oversize cut blanks are employed in this operation.

Combination punching, blanking, and shaving dies can be used for laminates up to 1/8 in. in thickness. These dies are commonly known as "double decker" dies, and the blanked piece is pushed through the shaving cutter on the same stroke as the blanking operation.

Broaching: Broaches can be used to produce square, hexagonal, and other polygonal holes, irregular shapes, key-ways, etc. The laminated structure makes it necessary to use a special broaching procedure.

When the cutting is to be across laminations, material must be backed up with a mild steel or brass plate which forms a slide fit with the last cutting tooth on the broach. This helps prevent fraying and breakout. When cutting is done parallel to the laminations, a fixture applying pressure at right angles to the laminations should be used. Ample chip room between the teeth of the broach should be provided, based on the depth of cut per tooth. A cut of 0.001 to 0.005 in. per tooth can be taken with the pitch ranging from 1/4 to 3/4 in., as determined for the material and the particular type of operation.

Sanding and grinding

Laminated plastics can be sanded on a belt or disk sander. Surface sanding on drum-type machines may be used to finish work to extremely close tolerances and to insure parallelism of opposite surfaces. Double-spindle grinders can be used for grinding two opposite parallel surfaces at the same time. In such instances, the work is placed in a fixture which is pushed between the wheels.

Sanding may be either dry or wet. Dry sanding makes use of a relatively coarse paper (120 to 160 grits to the in.). If a finer finish is desired, the sanding machine must be adapted for wet operation. This means that the work must be cooled with water or other coolant. Otherwise, the heat generated would cause particles of resin to embed themselves in the abrasive cloth. With wet sanding, paper as fine as 180 or 220 grits/sq. in. may be used, providing a so-called "satin" finish.

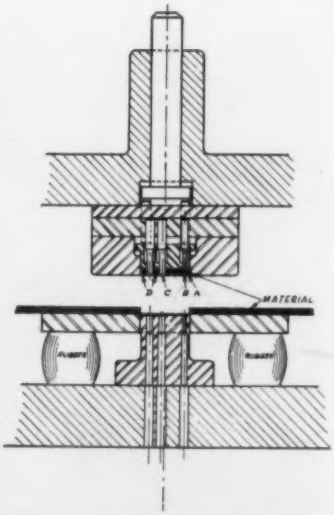


Fig. 8: *A* and *B* are poor punching designs, *C* and *D* are better (punch is larger)

Other types of finishing

Included under this heading is burring, tumbling, cleaning, and buffing, all or some of which are generally necessary to finish a fabricated part. Much of this work may be by hand, in order to remove completely objectionable burrs and fuzz.

Various polishing agents can be used in "tumbling" fabricated pieces in standard revolving barrels. Buffing with standard rag buffing wheels will give the material a smooth finish, and the use of rouge will be helpful in restoring high polish to machined surfaces.

Grinding tubes and rods

A centerless grinder, equipped with a silicon carbide wheel running at a surface speed of 9000 ft./min. is used for finishing rods and tubes. In addition, a vertical belt sander is used for finishing operations on many types of tubing. The grit size is determined by the finish desired. To obtain a buffed finish, a "slick" belt run at about 4000 to 6000 surface ft./min. is used with a suitable compound.

References

Consult the Subject Index and Directory Index for further information on machining laminates.

"Wizardry in circuitry," MODERN PLASTICS *31*, 91 (Apr. 1954).

"Automatic machining of laminates," MODERN PLASTICS *30*, 119 (Oct. 1952).

"Counter tops molded to shape," by L. G. Derbyshire, MODERN PLASTICS *29*, 103 (Apr. 1952).

"Fabrication of decorative laminates," Brit. Plastics *25*, 90 (Mar. 1952).

"Postforming thermosetting laminated plastics," by W. I. Beach, Mach. *58*, 171 (Dec. 1951); *58*, 172 (May 1951); *59*, 180 (Sept. 1951); *59*, 169 (Dec. 1952).

Molding Reinforced Plastics

BY HARRY T. DOUGLAS*

The term "reinforced plastics" basically refers to any plastics materials containing reinforcements of one kind or another. In its broad sense, it even covers such products as high-pressure decorative or industrial laminates. Trade usage, however, has relegated the description "reinforced plastics" to those reinforced plastics materials that can be molded into *complex* shapes and sizes with pressures ranging from simple contact to the higher forces generally involved in matched die molding. Since the major volume of reinforced plastics produced are manufactured with thermosetting polyester resins reinforced with fibrous glass, it is this combination that is generally implied when one speaks of reinforced plastics.

Resins and reinforcements

Polyester resins, the most widely used resins in the field of reinforced plastics, harden by chemical change and are not subject to resoftening or reforming. As the resin is received, it is somewhat viscous. However, the degree of fluidity can be controlled and adjusted by the addition of styrene which joins in the reaction and does not volatilize. Various catalysts are used to bring about the desired reaction and the subsequent hardening of the resin, either with or without pressure and externally-applied heat.

The popularity of the polyesters is based on their unique properties. They are easy to handle, can be applied by a doctor blade, or even poured or painted on the fibers. The cure is a complete reaction as nothing is given off in the way of volatiles or condensates or taken on during the curing cycle The resin can be used with or without pressure and with or without heat—making it possible to manufacture almost any size product in lightweight, low-cost molds.

To develop the great strength of the reinforced plastics product, however, glass or other fibers must be used for reinforcements, much as steel rods are used in concrete. The polyester resin acts as a binder to transfer loads through the cured and hardened resin to the stronger reinforcing material. There are several kinds of glass fibers used in the laminating process: 1) roving, a spool-like package of continuous glass strands which is most suitable to applications where unidirectional strength is required; 2) yarns, which can be twisted together and woven into a great variety of fabrics; and 3) fibrous glass mat, a random accumulation of cut strands rolled into sheets.

The impregnation of woven glass cloth or fibrous glass mat or rovings with polyester resin, plus the application of a catalyst results in a strong, dimensionally stable, lightweight material ¼ the weight of steel and about ⅓ the weight of aluminum. The physical properties are about the range of other plastics and compare favorably with metals. Strength/weight ratio in tension and compression is better than steel and about the same as magnesium. It possesses outstanding impact resistance, durability, corrosion- and rust-proof characteristics, and has superior arc resistance, low dielectric constant, and good power factors.

In recent months, considerable work has been done with the use of resins other than polyesters (e.g., epoxies, etc.) and with the use of fibers other than glass (e.g., synthetic fibers, asbestos, etc.) either by themselves or in conjunction with glass.

Apart from glass fibers, probably the highest volume of fibers now being used are sisal and asbestos, primarily in the field of premixes and prepregs. Although some strength is lost, sisal offers low-cost, medium-impact properties and high bulk. For a variety of applications, such as furniture frames for upholstered pieces where cost might be a prime consideration, sisal can be

Matched metal molds are used primarily for quantity production runs where faster production rates can offset initial high cost of the molds. (Photo, Lunn)



* Executive Vice Pres., Lunn Laminates, Inc., Oakwood Rd. and W. 11 St., Huntington Station, N. Y.

Recent Developments and References were prepared by the editors.

substituted completely or as a part of other materials in the reinforcement.

Bag molding

Reinforced plastics products really came of age with the development of "bag molding." In this process, a flexible bag or blanket, such as a polyvinyl alcohol or rubber blanket, is placed over the plied layup and either pressure is applied against the layup or a vacuum is drawn between the bag and the mold during its curing cycle to remove excess resin and air.

The layup consists of impregnated layers of fibrous glass fabric placed in a mold. Unskilled labor can easily be trained to do the work.

In order for the fibrous glass mat to become a part of the laminated product, resin is applied by rollers or poured from a container onto the layup and distributed carefully. The parts are then cured by heat or through the stimulation of a suitable catalyst.

Autoclave: By the autoclave molding method, steam or air may be used as a source of pressure on the layup material after vacuum has been drawn. The mold and layup are placed in the autoclave and pressure applied in the closed chamber. It is essential that no leaks exist in the bag or between the bag and the mold because the steam or air will be forced into the laminate causing spoilage.

Pressure bag molding: This process, a variation of the autoclave method, consists of a tight-fitting cover over the bagged layup which allows the introduction of increasing pressures on the laminate.

Contact molding: In those applications in which relatively low-volume runs are called for, max-

RECENT DEVELOPMENTS

A new type of press and mold (Sterling Precision Corp., Fibre Glass Plastics Div.) is capable of mass production of large reinforced plastic shapes by a process which makes void-free moldings. The new technique is equivalent to metal-die molding but is free of the physical limitations in tool cost and production methods inherent in the process. Parts of practically unlimited size and depth of draw are possible, and close dimensional tolerances and uniform physical integrity can be maintained. Automobile tops and trailer bathtubs are already being molded by the new method.

A reinforced plastics swimming pool (Delorich Enterprises, Inc.), 84 ft. long, 36 ft. wide, and from 3 to 11 ft. deep, built for the Red Lion Country Club in York, Pa., is probably the largest reinforced plastics item ever fabricated.

A new flexible glass fabric-reinforced polyester (*Conoglas,* Continental Can Co.) has been developed for lining bins, tanks, freezers, freight cars, trucks, and similar food storage and shipping containers. The material imparts a durable, wear-resistant, stain-resistant, and waterproof surface to containers, will not support the growth of mold or fungus, and is unaffected by alcohol, mineral acids, vegetable oils, salt water, weak alkalies, toluol, heptane, carbon tetrachloride, and other chemicals. It is available in rolls up to 150 ft. in length or in cut-to-size sheets.

Production of 1600 air conditioning ducts was accomplished in 17 days in a reinforced plastics mold, 53 in. long, 22 in. wide, 10 in. high, and weighing 1000 pounds (Apex Plastic Co.). This method of plastics tooling for molding is capable of producing as many as 10,000 to 12,000 pieces in matched plastics molds for short-run jobs or whenever it is essential to have finished pieces before the metal molds can be built.

A pre-impregnated fibrous glass-reinforced phenolic laminating material (*Conolon 506,* Narmco Resins & Coatings Co.) was developed specifically for ease of handling, curing, and fabrication in the production of aircraft components which must perform at elevated temperatures over extended periods. In fabricating structural components with this material it is necessary only to cut the desired pattern from pre-impregnated "B" stage laminating material, lay up the material, and cure the final part. It cures at pressures as low as 15 p.s.i., and can be fabricated on inexpensive disposable molds.

An amber-colored, fluid epoxy laminating resin (*Epocast 17,* Furane Plastics, Inc.) used in conjunction with a hardener is suitable for low-pressure laminating of fibrous glass into structures capable of withstanding high-temperature operation No solvents or volatiles are present, and the activated resin may be immediately applied to glass cloth. The high-temperature properties of laminates using this resin are obtained by postcuring at temperatures of 400 to 500°F.

A laminating resin (*Eccomold L 65,* Emerson & Cuming, Inc.) with low loss and low dielectric constant is designed for applications such as radomes and printed circuit boards. It is a thermosetting material. Parts made from it will withstand 300° F. continuously. Another laminating material (*Eccomold L 28*) of this manufacturer is a general-purpose epoxide which has been selected for radome and laminated sheet stock applications. An epoxide material (*Eccomold L 266*) which can be used continuously at 500° F. and for short periods as high as 600° F., and a low-loss, nonflammable polyester (*Eccomold L 44*) are also available.

A thixotropic laminating gel coat (*Resin 604A,* Marblette Corp.) with fast cure and a laminating resin (*Resin 607*) are now available in premeasured quantities. They are offered in cases holding six 1-pt. cans, along with the requisite quantity of hardeners to be used.

imum strength is not a factor, and only one side of the reinforced plastics part needs a smooth surface, contact molding is recommended. No pressure is involved. The resin is applied by brush or roller, thus excluding air bubbles.

In many instances, up to 4000 parts can be economically produced by these manual methods. Above this quantity, because of the labor involved, matched die molding should be considered.

Matched die molding

To produce large quantities, matched dies, which last longer, produce more parts with both surfaces relatively smooth, turn out pieces faster, and minimize trimming and finishing steps, are used. In this technique, the reinforcing material and resin are placed in the heated molds, and the molds are brought together by pressure. Pressures used are from 100 to 400 p.s.i. The molds invariably close against stops which determine part thickness.

Although this is by far a faster method of producing reinforced plastics parts, the initial outlay for matched dies is much greater than for single male or female dies. A guarantee of a large order or repeat orders is necessary (probably in lots of 4000 or more) to make this an economical investment for the molder. In matched die molding, metal dies, although most expensive, are used because of their accuracy, long life, and the fact that they can be readily heated. Some work has been done with matched plastics dies, and a combination of metal and plastics dies, but it is difficult to predict the life of these molds. They do not transmit heat quickly, although they are cheaper to manufacture.

The longer life of matched dies and the faster production rates often make the higher initial investment rewarding. Shorter molding cycles result in lowered labor cost, and product thickness is more easily controlled.

The smooth surface is due in part to die finish but mostly it is the result of overlays. With new research and development nudging production progress, larger pieces are possible now which were unknown even a year ago: larger boat hulls; one-piece lavatory units consisting of toilet, sink and wall section; double-shell seats; more decorative translucent lighting panels; and sectional room dividers.

Vacuum injection molding

There are several methods employed in matched molding. One of the early milestones in the field of reinforced plastics is vacuum injection molding. This is still used by industries where speed in production is not essential, e.g., in making limited quantities of sample parts.

Primarily the process was developed as a solution to making large parts on inexpensive molds and producing good inner and outer surfaces. These molds were usually of plaster, reinforced plastics, or metal with smooth inside surfaces. The best feature of this method is that the male and female mold surfaces produce a finished part with a smooth finish, eliminating bag wrinkles, and lending itself to limited production. If a larger quantity order later develops, matched metal dies are the next logical step.

In vacuum injection molding the male mold is constructed incorporating a recess or lip into which the base of the female mold sets. The female mold has one or several vacuum outlets on top permitting air evacuation.

Care should be taken that, when the female mold is lowered, there is no mismatching. To offset any misalignment in the mating of the molds, guide pins should be used.

The vacuum action commences after a room temperature resin is introduced into the recess or lip. The resin is drawn up from the recess and impregnates the reinforcing material. Not more than one foot of mercury is necessary; otherwise, bubbles might develop from the boiling of the styrene.

The resin impregnates the laminate evenly if the material is distributed uniformly. Properly done, it becomes practically a void-free laminate. When the resin appears through the sight gage the vacuum should be discontinued to permit the resin to harden. For easy removal of parts, back-off bolts are screwed against the product to permit lifting the female mold, and compressed air injected through the outlets beneath the male mold, freeing the finished part.



The first structure of its kind to be molded of reinforced plastics, this submarine fairweather withstands corrosion by salt water. (Photo, Lunn)

An interesting advantage of this technique is that it is possible to make an almost transparent mold which gives a visual picture of the resin being drawn through the laminate and up to the top of the mold. This helps in determining when to turn the vacuum off at the proper sequence. It is very often advantageous to clamp off the vacuum several times during the operations to let the resin level out by gravity and prevent channeling. This offsets the tendency of the resin to go directly to the vacuum port and leave large voids. When building the required number of plies and before molds are clamped, it is also an advantage to include in the lay-up a stiff and springy ply of mat which accommodates the passage of resin.

Additional considerations in favor of vacuum injection molding are: producing large, intricately shaped parts on inexpensive molds; molding parts with varied wall thicknesses; making reinforcements, ribs, and other interior structures as part of one unit; eliminating as large an amount of finishing as may be necessary in bag molding opera-

tions; using inexpensive equipment; and saving on materials by permitting a closer control of the resin and glass supply.

Some of the disadvantages to note are: the time element involved in the initial lay-up and molding the part; the low resin-to-glass ratio; the inconsistent rising of the resin to the top of the mold; the additional cost of a male or female mold; and the chances of a leak occurring during the molding cycle which would be difficult to locate during cure and which would subsequently produce a damaged piece.

Injection molding

Another method of matched die molding extensively used is injection molding of reinforced thermoplastic molding compounds, where volume production is called for. By arranging cavities in series, it is possible to produce simultaneously the various component parts in an assembly. The disadvantages of the technique are the considerable capital outlay and the high die cost and setup time.

From the elaborate preparations necessary in this type of production, it is easy to see that production should continue without interruption for an extended time. In some cases, an entire week is involved in the run of just one set of parts. The order must be a sizable one to offer a sufficient return on this costly investment.

Although other thermoplastics are used, the most suitable reinforced plastics material for this specialized type of molding is polystyrene containing fibrous glass strands with the reinforcing compound in pellet form. This method produces rigid parts resistant to changes of temperature and possessing excellent tensile and flexural strengths. Increasing uses in the military field for numerous parts made by pressure injection molding have expanded the market for many applications of this technique.

Depending on the product design and weight, the average operating temperature might be from 450 to 600° F., with corresponding cycles of 120 to 30 seconds. Higher temperatures often cause discoloration. On the other hand, cold molds for short cycles produce inferior parts with surface imperfections, and it is advisable to heat the mold surfaces to approximately 180° F. by hot water or oil circulating through the mold surface. Adequate pressures are imperative on the reinforced plastics materials in the molds as a slight miscalculation can ruin a large number of parts set up in the various cavities.

Premixes and prepregs

Leading the way into expanded new uses for reinforced plastics is the group of premix compounds. These plastics compounds possess different characteristics than the laminate materials.

Laminated products, on the one hand, are formed by pouring or rolling the resin on the fibrous glass mat, whereas with premix plastics compounds, these materials are mixed together before the molding process. Complex and unusual shapes with varying cross-sections, which would be difficult to attempt with a laminating method, can be molded with premix materials. The physical strength is substantially lower for premix compounds, but where this is not an important consideration in the finished part, or where thickness can be substituted for high unit strength, premixes can be used to obtain such advantages as: good contours at low molding pressures; dimensional stability; weather resistance; stable dielectric properties; and high impact strength.

Another time- and labor-saving development which is substantially gaining ground in the reinforced plastics field is prepreg molding. This utilizes fiber or other reinforcing materials which have been pre-impregnated with a catalyst resin and can be cut into patterns very readily. Prepregs have been widely used in other molding operations and their easy workability in the reinforced plastics industry have given these materials an added impetus as labor-saving devices. All resin calculations, mixing, and applying are eliminated. The improved resin usually selected is a diallyl phthalate type which has the added advantage of not only being tack-free, thus making it cleaner to work with, but also has the facility of readily adhering to itself and allowing easy build-up of ply.

Pre-impregnated materials can be made up of fibrous glass mats, paper, cotton, linen, or synthetic woven fabrics, with the selection of a specific resin depending on

Low-pressure contact molding techniques are used to turn out this reinforced plastics section for a Geodesic dome. After molding, parts need only be trimmed to be readied for installation. (Photo, Lunn Laminates)



the final usage. Storage life of the prepreg materials has extended to six months and longer in some instances.

The even distribution of the resin helps turn out better-made parts. Less waste also occurs with this material because it is easier to handle than untreated glass cloth. Although prepregs are more expensive than standard materials, the considerations in favor of estimated time saved should be investigated by the molder to ascertain whether this is applicable to his individual needs.

Dies

The selection of dies for molds is dictated by the kind of manufacturing the reinforced plastics molder intends to follow. Should he start with bag molding, dies constructed of plaster, plastic, or metal could be utilized depending on quantity, quality of parts, and the economics of the part run.

Plaster dies have an extra short life and are used primarily in making prototype parts. Dies of reinforced plastics utilizing polyester or epoxy resins, often filled with metallic fillers, have been used successfully in pilot productions.

High-volume manufacturing demands the use of aluminum or steel dies which produce parts with close tolerances and turn out products quicker and with a comparatively smooth finish. Machined and polished aluminum dies have yielded up to 10,000 pieces.



Aluminum dies are used to mold small radomes for housing military products and shell structures. (Photo, Lunn)

Some of the present objects made with aluminum dies are: safety helmets, military chest protectors, office fixtures, aircraft and marine parts, and trays.

Steel dies, though more expensive than aluminum, have excellent strength properties and lon life. The surfaces are painstak ingly machined to eliminate eve the minute imperfections. Th use of steel dies has pushed th reinforced plastics industry so fa ahead that products manufac tured through this process hav replaced completely other stand ard materials.

Among the numerous articles produced through this technique are: guided missile parts, pleasure craft, automobile and truck body parts, fruit and vegetable crates, tote boxes, trays and furniture.

Hood for outboard motor is matched metal molded in a 150-ton press. After molding, hood is sprayed with a special melamine-base enamel paint that requires subsequent oven cure for final hardening. (Photo, General Tire & Rubber)



References

Consult the Subject Index for additional information on the molding of reinforced plastics. See also the Low-Pressure Laminating Resins Chart and the Laminates Chart for information on properties and trade names. For sources of reinforced plastics, see the Directory Index, p. 1018.

"Mass production for reinforced plastics," MODERN PLASTICS *34*, 222 (Dec. 1956).

"Investigation of plastics for toilet bowls," by S. B. Swenson and H. Graus, MODERN PLASTICS *34*, 164 (Dec. 1956).

"From jeeps to giants," MODERN PLASTICS *34*, 103 (Nov. 1956).

"New press, new process for big reinforced plastics pieces," MODERN PLASTICS *34*, 106 (Sept. 1956).

"Miniature car made of reinforced plastics," MODERN PLASTICS *33*, 222 (May 1956).

"Reinforced plastics school desks," MODERN PLASTICS *33*, 228 (Apr. 1956).

"No aid to enemy," MODERN PLASTICS *33*, 96 (Feb. 1956).

"Glass/polyester sports car body," Brit. Plastics *29*, 359 (Oct. 1956).

"Reinforced plastics springs," by F. W. Reinhart and S. B. Newman, SPE J. *12*, 11 (Aug. 1956).

"Glass polyester reinforced concrete pipe," Brit. Plastics *29*, 298 (Aug. 1956).

"Continuous resin injection for glass fiber molding," by J. Rees, Brit. Plastics *29*, 294 (Aug. 1956).

"A radically new press and mold for mass production of large plastics shapes," by C. H. Van Hartesveldt, SPE J. *12*, 24 (July 1956).

Preforming Fibrous Glass

BY W. W. THOMPSON* and R. G. ADAMS*

There are three basic methods which have been developed for the preforming of fibrous glass. They are: 1) plenum chamber; 2) directed fiber; and 3) water slurry.

Plenum chamber

The plenum chamber method is perhaps the most widely used process. Fibrous glass rovings are fed into a cutter where they are cut to lengths between ½ and 2 inches. The 2-in. cut is most often used, although shorter cuts, or a combination of cut lengths, are also in common usage. From the cutter the fibers fall into the plenum chamber, or into a chute that carries them into the plenum chamber. They are deposited on a perforated screen as the air is exhausted from beneath the screen. (See illustration, below.)

To help insure a uniform deposition of strands, the preform screen rotates. In addition, internal baffles on the screen are frequently used to aid in the proper deposition of fibers. A resinous binder, which may be either a powder, or a liquid, is applied at the same time the glass is being deposited. Liquid binders, usually polyester and water emulsions, have been found to be the most satisfactory for the majority of applications.

The cutter acts as a feed mechanism for the glass; thus glass input can be controlled by a timer. The input of the resinous binder can also be controlled by a timer, although manual spraying is occasionally used.

The plenum chamber machines are the most nearly automatic of the air-type preformers and thus produce the highest rates of production. Their operation is somewhat cleaner since they are enclosed. A big advantage of the plenum chamber method is that once it has been set up to do a particular job, very little operator skill is required to get reproducible results throughout a production run.

The disadvantages center around the long setup or tryout time which may be required whenever a new part is started in production. This is due to the fact that the fiber deposition depends entirely upon the correct flow of air through each part of the screen. To achieve this, intricate baffle systems within the screen often have to be developed. This setup period can take several days.

The plenum chamber machine is therefore most adaptable for applications for which it can be set up to run off a part continuously for a long period of time.

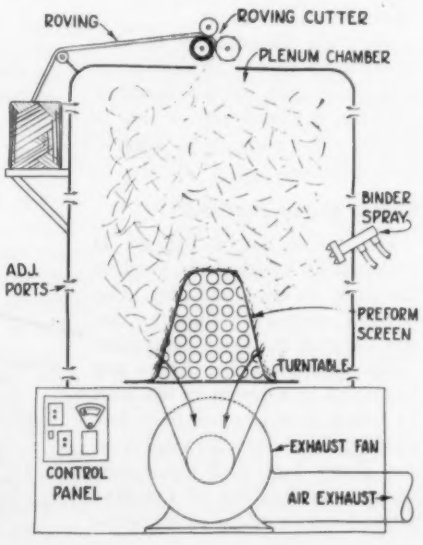
Directed fiber method

In the directed fiber method there is no plenum chamber over the screen. The preform screen is located on a nearly vertical turntable behind which is located an exhaust fan. The cut fibers are directed at the preform screen from the flexible hose of a separate cutter unit. The cutter unit consists of a roving cutter, a blower provided with a venturi where the cut fibers are introduced, and a flexible hose.

The rovings are cut in the roving cutter, dropped through a short duct, and are introduced into the venturi air stream, which blows them out of the flexible hose. The operator directs the stream of fibers at the slowly rotating preform screen on the turntable. The binder is simultaneously sprayed onto the piece by the operator.

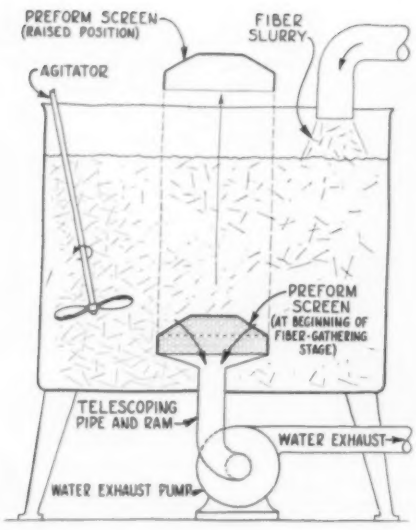
While the glass input is controlled by a timer, considerable operator skill is required to produce uniform preforms. He controls the distribution of both fibrous glass and the binder on the screen, and therefore the quality of the part. Where relatively lightweight preforms are being made, the operator can be aided by a strong light behind the preform screen.

One of the chief assets of the directed fiber method is that, given a skilled operator, a part can usually be put into production within a few hours after the preform screen is delivered. Baffling is seldom necessary in screens since a good operator can direct the fiber stream to any part of the screen. In the same manner, the operator can allow for varying part thicknesses where the changes are not too abrupt. It is also quite easy for the operator to add inserts, mat build-



Most nearly automatic of the air-type preformers, plenum chamber machines yield highest production rates and, once a job has been set up, require very little operator skill to get reproducible results throughout a production run

* Owens-Corning Fiberglas Corp., 598 Madison Ave., New York 22, N.Y.



Although a higher capital investment is required for the water slurry preforming method, the technique has many advantages: it is more automatic, faster production cycles can be achieved, and intricate shapes, abrupt changes in wall thickness, and very heavy walls are all possible

ups, or wire beads to the preform. Even in instances when a wide variety of different parts is to be made and change-overs are frequent, the directed fiber method is still adaptable. Several different sizes and shapes of parts can be run one after another on the same machine. The only adjustment the operator has to make is to set the proper cutter time for the part. (See illustration, below.)

This method has been shown to be adaptable to making very large parts, up to 120 sq. ft. in area, and over. The directed fiber method is also useful in preforming odd-shaped parts, such as a very long and narrow piece or large pieces with considerable open area in the center.

Although theoretically capable of the same rate of production as a single-station plenum chamber machine, a slightly lower rate is usually experienced with directed fiber machines.

Water slurry method

The water slurry method is very similar to methods used in the pulp molding industry. The chopped strands of fibrous glass are slurried in water containing cellulosic fibers. The fibers are deposited on a screen in the bath as water is exhausted from beneath it. The screen is raised from the slurry bath and the excess water is sucked out of the preform. Various ratios of glass-to-cellulosic fibers can be used although 80% fibrous glass and 20% cellulose seem to produce good results. (See illustration, above.)

Although it has many advantages over the airborne type of preform machines, the water slurry method is not widely used in the United States.

This method is the only one in which there is little or no scrap loss. It is more automatic and fast production cycles are possible. The preforms are tough and self-supporting without the addition of resinous binders. Intricate shapes, abrupt changes in wall thickness, and very heavy wall thickness are all possible. The initial capital investment for equipment is higher than for the air systems because more equipment is involved.

Although water slurry preforms handle easier than air-felted preforms, they usually have a higher bulk factor which sometimes leads to wrinkling. It is practical to use only a low percentage of filler in the molding resin because of the filtering nature of the cellulosic fibers; however, the resin can be pigmented and the preforms can be dyed for decorative effects.

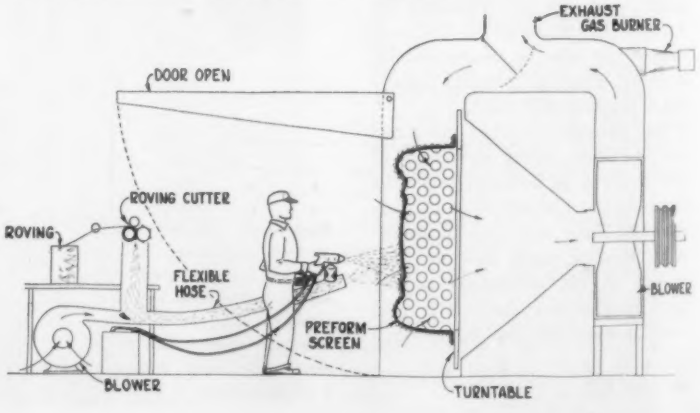
Production cycles

Production cycles depend upon the following factors: 1) the weight of the preform; 2) the number of roving cutters; and 3) the amount of hand work required. Where difficult shapes are encountered, or where high quality is required, the production cycles may be 20 to 30% longer than average.

For quality work, the majority of molders cut roving at about 1 lb./min. per cutter. While the cutter can cut fibrous glass at several times this rate, the uniformity of preforms falls off considerably at the higher cutting rates. Where lower quality preforms can be tolerated, many molders cut at the rate of 2 to 3 lb./minute. These cutting rates apply to both the plenum chamber and the directed fiber methods.

In actual practice, the full capacity of the preform machines is seldom used, because so much depends on the ability of the operator to keep up with the machine.

To offset a slightly lower production rate, directed fiber machines are designed so that, given a skilled operator, a part can usually be put into production within a few hours after the preform screen is delivered



Sandwich Constructions

RECENT DEVELOPMENTS

A unique foamed styrene-and-paper sandwich material (*Fomecore Board*, Monsanto Chemical Co.) consists of a core of stiff foamed styrene with a sheet of specification kraft paper on either side. It retains high compression strength under conditions of severe humidity and provides excellent insulation qualities. A container (St. Regis Paper Co.) made of this board is light in weight and strong enough to withstand long distance shipping under the high humidity conditions of refrigerator cars and trucks.

Structural panels of phenolic-impregnated kraft paper honeycomb and polyester-paper and polyester-fibrous glass (*Conolite*) faces are now being produced in effectively continuous lengths (Honeycomb Div., Continental Can Co.). Both the honeycomb and the facing are produced in continuous lengths, with size of panel controlled by the size of the bonding press. The hot press used by the company is capable of producing panels 200 in. long by 48 in. wide.

In an adaptation of the "lost wax" process, a new thermoplastic (*Hot-Melt H-883-A*, Furane Plastics, Inc.) is used for filling honeycomb cores to facilitate later machining of stainless steel honeycomb structures. After machining, it is melted from the honeycomb and the structure is cleaned with hot water.

Plywood with a weatherproof overlay (*Crezon*, Crown Zellerbach Corp.) will be used for such products as sidings, signs, boats, and handyman panels. A resin-impregnated cellulose fiber sheet is applied to the plywood panel and then permanently fused to wood under heat and pressure.



Aircraft component is fabricated of sandwich made up of aluminum skins over aluminum honeycomb core. Lightweight structure offers sizable weight savings. (Photo, Narmco Mfg.)

Sandwich constructions are multilayered structures composed of thin, strong facings integrally bonded to comparatively thick, low-strength cores. They are often flat panels that can be fabricated into an end-product, but they can also be curved shapes, e.g., curved airplane radomes made of fibrous glass-reinforced plastics sandwiches.

Sandwich construction materials have shown a remarkable growth within the past few years. Indeed, there are surprisingly few parts in aircraft, building construction, small boats, and many other fields which have not already had at least one prototype made out of sandwich materials. When designed as a structural sandwich, the entire assembly provides high strength and stiffness in proportion to its weight.

Introduction to this article is based on material supplied by Andrew C. Marshall, Western Regional Manager, Hexcel Products, Inc., 955 61 St., Oakland, Calif.

Recent Developments and References were prepared by the editors.

Adhesives

Much of this growth in the industry can be traced to developments in the use of synthetic resin adhesives to provide an integral, rigid, and reliable attachment between the core and the facing of the sandwich.

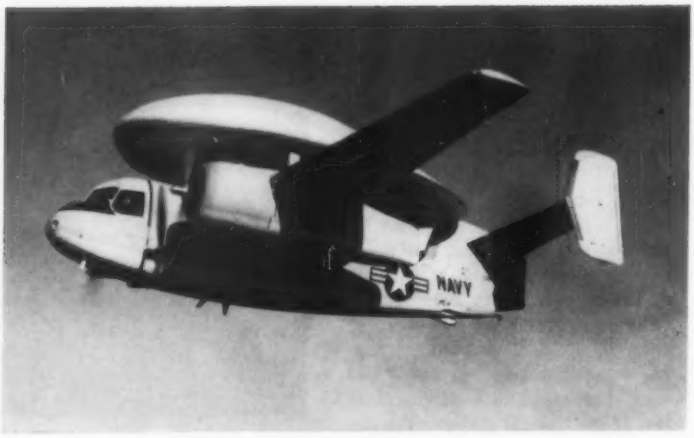
The bond may be effected by using the same resin as is used in the facings, e.g., polyester resin for polyester-fibrous glass facings. It may also be applied separately in the form of a tape or paste compounded of epoxy, phenolic, vinyl, rubber, acrylic, or other resins, or as is usually the case, a combination of several resins.

In designing aircraft parts where high strength and temperature stability is sought, these adhesives usually have a glass or cotton fiber skrim cloth as a carrier. The function of the cloth is not only to facilitate handling, but to improve resistance to abuse and peel failures as well. Cost of this form of adhesive can run in excess of $3/sq. ft. of sandwich.

At the other extreme are the liquid resins used for bonding architectural panels for exterior building facings that can be handled in tank trucks and spray guns. Cost in such instances is only 20¢/sq. ft. of panel. In either case, for a successful sandwich construction, the adhesive must be selected for its ability to maintain integral attachment between the core and the facing for the entire expected service life of the part.

Facings for the sandwich construction can be flat sheets of plastics, paper, wood, metal, etc.

The core materials also show wide variety. The most important job of a bonded core material in sandwich constructions is to stabilize and stiffen two thin facings having relatively high tensile strength so that the major part of a load is borne by the skins. The bonded core also converts the two skins into a single structure of great rigidity so that they deform much less under load than they would unjoined. To serve these purposes, the core must have high compressive, shear, and tensile strengths, and a fairly high modulus of rigidity in shear;



Light weight and structural efficiency, despite large size, characterize airplane radome made of reinforced plastics honeycomb core sandwich. (Photo, Hexcel)

in many cases, the core must also serve as a thermal or electrical insulator.

Honeycomb Core

BY ANDREW C. MARSHALL*

Honeycombs are among the most important types of core materials used in sandwiches today —and still growing fast. Because of its structure (based on the concept of a bee's honeycomb), it not only has great strength per pound, but also excellent thermal and insulating properties.

An estimate of 1956 core sales would break down as follows: paper honeycomb—$4 million; aluminum honeycomb—$4 million; fibrous glass honeycomb—$2 million; stainless steel honeycomb —$250 thousand. It is anticipated that the growth in 1957 will be in the inverse order of the above list, with stainless steel growing five- or tenfold and the paper honeycomb growing some 50 to 100 percent.

Some of the honeycomb uses deserve special mention. Curtain walls for the building industry, for example, are expected to show a sharp increase this year. The appearance of the optically-flat surfaces gained through the use of sandwich materials in this type of construction has already attracted attention of architects, and several office buildings and airport terminals, using as much as 75,000 to 100,000 sq. ft. of sandwich materials each, have recently been erected.

The end uses of the various types of honeycomb available are many and diverse. Most of it, however, goes into the following major markets:

Honeycomb core	*Facings*	*End uses*
Paper	Porcelainized steel	Curtain walls in buildings
	Fibrous glass	Small boats
	Wood veneer or metal	Aircraft interiors
Aluminum	Aluminum	Aircraft structures
	Porcelainized steel	Curtain walls in buildings
Fibrous glass	Fibrous glass	Radomes and antenna windows
Stainless steel	Stainless steel	Aircraft structure

Also new in the area of applications for sandwich materials are structures exposed to the intense sound damage areas in turbo-jet aircraft. Typical of these structures are the wing assemblies aft of the engine exhaust on many aircraft. Without the unique properties of the sandwich materials, it would have been virtually impossible to design a structure with reasonable weight and service life in these areas.

Another new idea in sandwich structures is the use of both foamed plastics and honeycomb materials in the same sandwich. Using this technique, local strength may be increased fourfold and a shear attachment means is provided.

Finally, the success of many types of aircraft as radar warning picket ships owes much to the fibrous glass honeycomb sandwiches of which their huge radomes are constructed. These domes are as large as a backyard swimming pool (the rotating antennas inside are approximately 18 ft. in diameter) and yet are easily carried aloft without seriously impairing either the pay-

* Western Regional Manager, Hexcel Products, Inc., 955 61 St., Oakland, Calif.

Sandwich panel used in manufacture of all-plastics refrigerator has foamed styrene core and high-impact styrene alloy sheet faces. (Photo, Westinghouse)



load or the performance of the aircraft on which they are mounted.

Among the newer developments in the offing are plastics sandwiches capable of service at temperatures of 800 to 1500° F. Adhesives are being readied that will permit applications at service temperatures of over 700° F. Fibrous glass core-aluminum skin sandwiches, already winning the competitive battle with all-aluminum structures, have also recently undergone marked improvement. Bonded primary structures based on sandwich materials and now found only in two aircraft (Convair B-58 and Temco TT-1) also show promise of becoming standard in the industry.

Balsa Wood Core

BY RICHARD MARK*

Balsa wood with its high strength/weight ratio and other advantages (see Table I, right) has been used for quite some time as a structural core for aircraft sandwich construction. More recently, the use of balsa has been extended to include many applications in reinforced plastics where thick sections are required for thermal insulation and/or rigidity. Included among these applications are: tank trailers that transport bulk milk and orange juice; ladders for use in telephone line service; pleasure craft; and others.

* Balsa Ecuador Lumber Corp., 500 Fifth Ave., New York, N.Y.

TABLE I: Characteristics of balsa wood

Forms available	*End-grain—rigid blocks*			*Flat-grain—rigid boards, panels, blocks*		
Standard sizes	Thicknesses: 3 to 29 in. Widths: 18 to 48 in. Lengths: 3 to 36 in.			Boards: Thicknesses: 1¼, 1¾, 2¼, 2¾, 3¼ in. Widths: random Lengths: 2 to 7 ft. Panels: Thicknesses: 1 to 3 in. Widths: 4 to 30 in. Lengths: 1 to 10 ft. Blocks: Thicknesses: 3 to 29 in. Widths: 3 to 36 in. Lengths: 1 to 10 ft.		
Density, lb./cu. ft.	4-9	9-14	14-18	4-9	9-14	14-18
Thermal conductivity, B.t.u./sq. ft./hr./°F./in.	0.67	0.99	1.24	0.30	0.44	0.55
Tensile strength, p.s.i.	1,745	2,630	3,500	105	150	205
Compressive strength, p.s.i.	1,020	2,090	3,080	75	125	170
Maximum service temperature, °F.	Varies with exposure time from 150 to over 500					
Coefficient of linear expansion, 10^{-6} in./in./°F.	0.199			0.776		
Moisture absorption, % by wt.	High alone; very low when part of sandwich structures					
Water-vapor transmission	Approx. 1.15 grains/da./sq. ft./mm. Hg for 1-in. thickness					
Dielectric constant	< 1.5 at $10^2 - 10^{10}$ cycles per second					
Dissipation factor	< 0.01 at $10^2 - 10^{10}$ cycles per second					

Because of its rigidity, the largest use for balsa cores has been in flat panels or straight beams. More recently, techniques have been developed for using it in curved structures.

Trimmed, curved end-grain balsa wood core sandwich is produced by laminating one skin to the core prior to bending. The balsa wood core is ½-in. thick. (Photo, Balsa Ecuador)



Foamed Plastics Cores

Foamed plastics also stand out as a lightweight, thermal insulating, and acoustical insulating core for sandwich materials—either as a foamed-in-place core or as a block or sheet of plastic foam cut to size and cemented in place between the two faces. Considerable attention has been attracted by a sandwich material made up of two sheets of high-impact styrene sheet laminated to a foamed styrene core and recommended for use in food processing plants, bakeries, etc., as a curtain wall in building, as a liner for refrigerator doors, etc.

For a complete review of the various types of foams available as core materials, see the Foamed Plastics Section, p. 334.

References

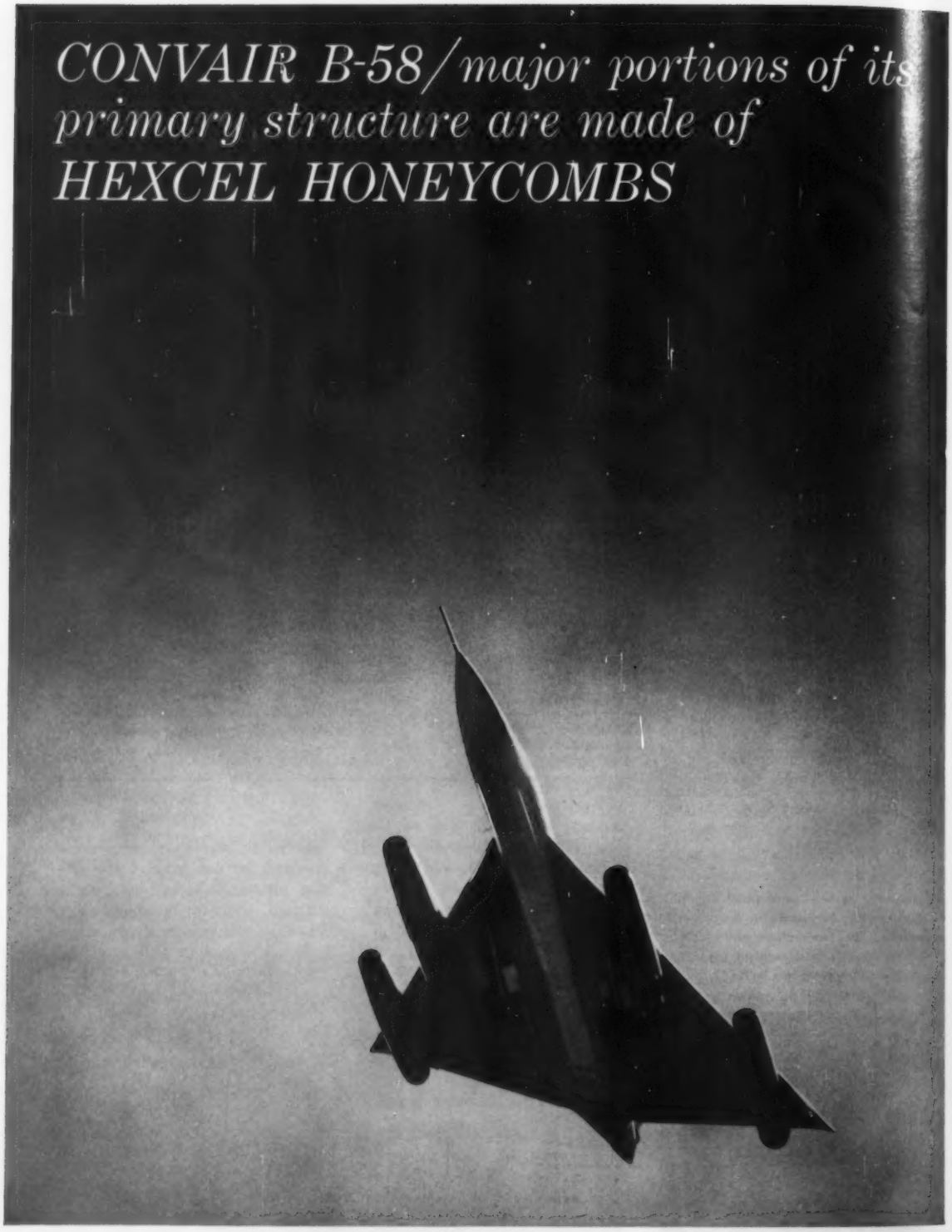
Consult the Subject Index for additional information concerning sandwich constructions. For sources of sandwich materials, see Directory Index, p. 1018.

"First all-plastics refrigerator," Modern Plastics *34*, 114 (Nov. 1956).

"Sandwich panel," Modern Plastics *33*, 352 (June 1956).

"Balsa core for reinforced plastics structures," by R. Mark, Modern Plastics *33*, 131 (May 1956).

CONVAIR B-58/major portions of its primary structure are made of
HEXCEL HONEYCOMBS



HEXCEL PRODUCTS INC.
America's leading producer of honeycomb core materials
951-61st Street, Oakland, California

PLANTS: OAKLAND, BERKELEY, CALIF.; HAVRE DE GRACE, MARYLAND • SALES OFFICES: INGLEWOOD, CALIF.; FORT WORTH, TEXAS



Contour

in molded fibre that solves your problems

Percentages of glass fibres may be mixed with cellulose fibres to meet your strength requirements.

Deep Draw...

Surpassing conventional methods by economy, durability and appearance in this one piece molding, the Hawley process is proven for deep draw forms.



movie projector case

Contour...

Contoured edge solves fitting problem to curvature of dashboard, permitting greater latitude in design considerations.



glove box

Style...

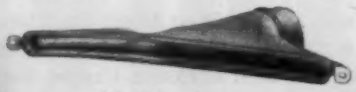
Compound curvature of design for sales appearance, strength through glass fibre reinforcement in stock produces amazing strength-lightweight ratio.



luggage

Insulation...

Low thermal conductivity of molded fibre restricts absorption and dissipation of heat, efficiently channelling it to windshield. Acoustic properties absorb fan noise, contour overcomes compact and intricate space problem.



defroster nozzle

Hawley

PRODUCTS COMPANY

ST. CHARLES, ILLINOIS

LONDON, ENGLAND • SYDNEY, AUSTRALIA • BUENOS AIRES, SOUTH AMERICA

Now...from U.S.G.

the most complete line of materials for plastic tooling!

U.S.G. experience, technology and research set new standards for epoxy laminating and casting resins

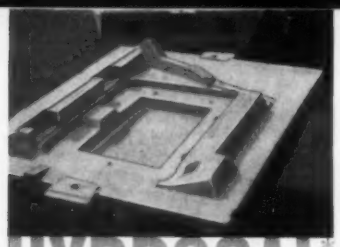
Now, you can do the entire job—from blueprint to finished pattern or tool—with materials from a single source, United States Gypsum. The addition of new EPOXICAL Tooling Plastic to the U.S.G. family of gypsum cements and plastics completes a line of materials for laminating and casting; makes U.S.G. an important part of the plastics industry.

Now, you're assured of unit responsibility; of quality materials that have been scientifically researched, thoroughly tested. A qualified U.S.G. technician will be happy to demonstrate how these U.S.G. materials can be applied to your plastic tooling problems.

FREE! Write United States Gypsum, Dept. 122, 300 West Adams St., Chicago 6, Ill. for this free literature: HYDROCAL Models and Molds (IGL-ITT-100); Vacuum Forming with ULTRACAL (IGL-ITT-55); EPOXICAL Laminating Resin (IGL-400); EPOXICAL Casting Resin (IGL-401).

USG UNITED STATES GYPSUM

UNITED STATES GYPSUM



HYDROCAL*

HYDROCAL gypsum cements are used for molds and original models to laminate or cast plastic patterns, dies, jigs, fixtures or foundry match plates and core boxes.



ULTRACAL*

ULTRACAL gypsum cements are used for vacuum forming models and molds. Offer high strength, improved heat resistance for prototype, short run and production applications.



NEW EPOXICAL*

NEW EPOXICAL tooling plastics permit laminating or casting of precise, economical epoxy resin patterns and models in half the time required by traditional techniques.

pioneering in ideas for industry

**HYDROCAL and ULTRACAL are trade marks Reg. U.S. Pat. Off. for super strength gypsum cement manufactured by United States Gypsum Company. EPOXICAL is a trade mark for epoxy resins manufactured by United States Gypsum Company.*

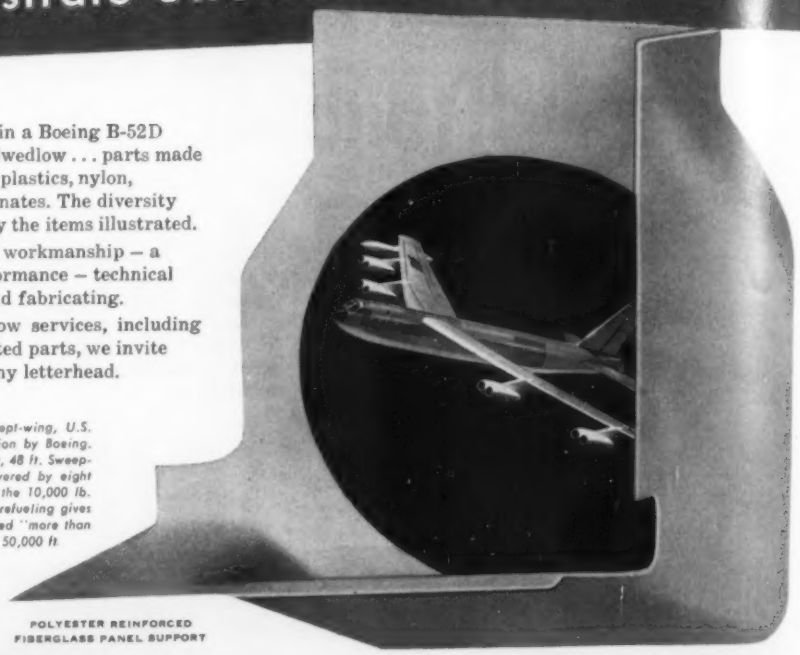
Fabricated plastic parts on Boeing B-52's demonstrate Swedlow versatility

Practically everywhere you look in a Boeing B-52D you see plastic parts built by Swedlow . . . parts made of laminated transparent acrylic plastics, nylon, heat-resistant, and fiberglass laminates. The diversity of shapes and sizes is indicated by the items illustrated.

Swedlow offers you highest quality of workmanship – a reliable record of delivery performance – technical expertness in formulating and fabricating.

For complete information on Swedlow services, including new "honeycomb" cores and fabricated parts, we invite your inquiry on your company letterhead.

The Boeing B-52D Stratofortress is an eight-jet, swept-wing, U.S. Air Force long-range heavy bomber now in production by Boeing. Wing span, 185 ft. Overall length, 156 ft. Tail height, 48 ft. Sweepback, 35 deg. Gross weight, over 400,000 lbs. Powered by eight Pratt & Whitney 157 turbojet engines, each rated in the 10,000 lb. thrust class. Boeing-developed "Flying Boom" aerial refueling gives the B-52D virtually unlimited range beyond the specified "more than 6000 miles." Speed, 650 m.p.h. Service ceiling, over 50,000 ft.



POLYESTER REINFORCED FIBERGLASS PANEL SUPPORT



Typical Swedlow Parts on the Boeing B-52D

PANEL SUPPORT

and... more parts fabricated by Boeing from Swedlow laminated sheeting



Die-cut liners. Specification BMS8-9B polyester fiberglass reinforced laminate.





Nylon resin reinforced by nylon cloth. Used primarily as fuel cell support. Specification BMS8-13A

Manufacturers of low and intermediate pressure reinforced laminates, press or continuously formed . . . molded parts by matched tooling and vacuum forming methods. Utilizing acrylic, polyester, phenolic, nylon, epoxy, silicone and related resins . . . fillers of paper, fiberglass, cotton, nylon, dacron, orlon, and combinations thereof. Honeycomb cores, parts with reinforced faces. Transparent plastic glazing materials, including stretched acrylic sheets and formed parts.

Swedlow
PLASTICS COMPANY

Los Angeles, California • Youngstown, Ohio

Please refer to Dept. 16

Important Facts About the $12 Billion Packaging Market . . .

PRACTICALLY ALL PRODUCTS are packaged. It's almost easier to count the industries that *don't* package than those which *do*. That's why the packaging market is horizontal . . . includes the thousands of companies that make products of all kinds that are packaged for shipment or sale.

Packaging is, in fact, so integral a part of business as a whole that it expands as business expands. In 1954, according to the U. S. Department of Commerce, the value of materials, supplies and services used in packaging the nation's output stood somewhere between 12 and 15 billion dollars. And as the national output of goods increases each year, so does the demand for packaging, packaging equipment and related supplies.

What the Market Uses . . . and Buys

The range of America's products are as wide as our ingenuity. And the variety of containers is equally broad. Depending on the nature of the product, its package can be a bag, barrel, bottle, box, can, carton, chest, crate, capsule, drum, envelope, jar, tube, vial or wrapper.

Often a package will be a composite of several of these forms and will use many materials: adhesives, coatings, cork, fabric, film, foil, glass, ink, wood, paper, plastics, tape, and wax.

To make these containers—and fill them—takes bag machines, bottling equipment, box machines, capping equipment, cartoners, conveyors, counters, die-cutters, filling machines, labelers, printing presses, scales, slitters, staplers, stitchers, unscramblers and vibrators. And they may also require such additional services as embossing, fabricating, laminating, plastic molding, and contract packaging.

All of these containers, materials, supplies, services and machines are part and parcel of "packaging." They're the factors that give the market its tremendous scope.

Who Does the Buying

The factors that control package selection are as complex as business itself. They include production, quality control, shipping, display, advertising, sales, promotion . . . and, often, outside packaging consultants. The purchase and specifications of packaging materials usually cuts across many departments of a company.

Because the buying influences are so diverse, it is difficult for salesmen to reach them all. Most suppliers, therefore, rely heavily on advertising to carry a good share of their selling lead.

How Modern Packaging Fits In

MODERN PACKAGING is the oldest and largest magazine serving the packaging field. Prior to its founding in September, 1927, the concept of packaging as a common function of many industries was not generally recognized, nor was it realized that these industries have common packaging objectives, techniques, problems and procurement needs.

MODERN PACKAGING changed all that. It gave the users of packaging everywhere a single reliable forum where mutual problems might be solved and where new packaging materials, methods and services could be publicized. As a result it gave packaging suppliers a *single* medium through which they could reach the various buying influences in the many industries that package the great bulk of the nation's goods.

Paid Circulation is Essential

Because of the intricate purchasing patterns involved in the selection and specification of package designs, materials and equipment, it's just not possible to select "packaging men" simply on the basis of job titles.

For this reason MODERN PACKAGING's policy of *paid circulation* is vitally important to advertisers. It is insurance that subscribers are directly and intimately concerned with packaging operations, because packaging men identify themselves and their interests by laying hard cash on the line.

Since the magazine's founding in 1927, its paid circulation has risen steadily—from 2,500 to its current all-time high of 20,600 out of a total print order of 24,500. The bulk of the remaining copies are used to provide additional rotating distribution for conversion into paid subscriptions.

Editorial Content

The editorial purpose of MODERN PACKAGING is to keep packagers informed of all the significant advances in the methods, materials and equipment of the art. Editorial feature space is devoted to carefully researched original articles. About 90% is staff written. 10% contributed by authorities in the field. Through the use of analyses, illustrations, case histories and "how-to-do-it" articles, the editors point out and interpret packaging trends.

Advertising Acceptance

Year after year, *more* advertisers invest *more* money in *more* space in MODERN PACKAGING than in *all other packaging publications* combined. And, last year, they set new all-time highs in both *space* and *dollar volume!*

Get More Facts

To learn more about the sales potentials in the packaging field for the products *you* make, just write to *Advertising Manager,* MODERN PACKAGING, 575 Madison Avenue, New York 22, N. Y.

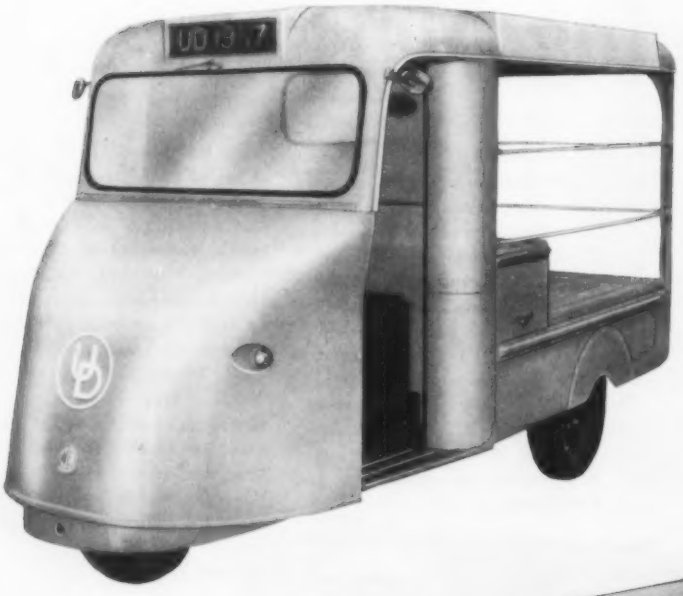
* * *

MODERN PACKAGING MAGAZINE

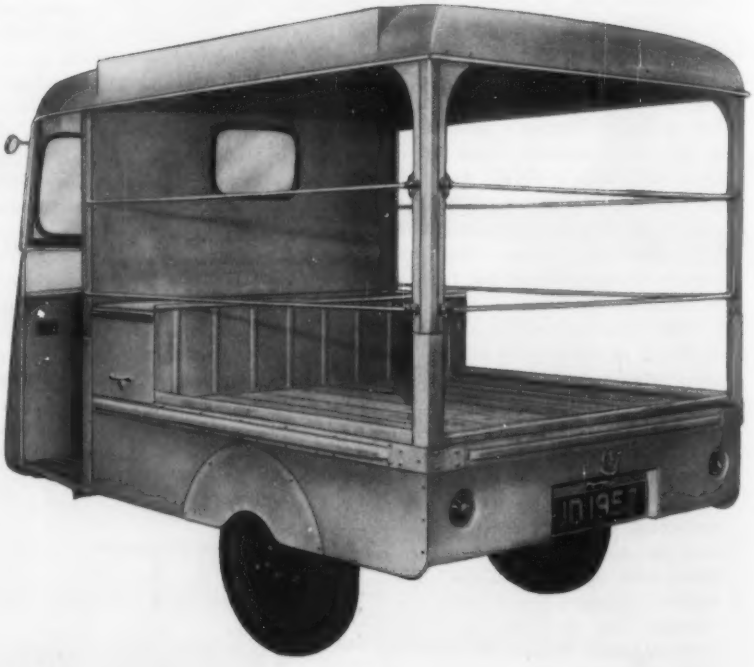
A BRESKIN PUBLICATION

Quality controlled 'deeglas'

in this all-plastic U.D. milk float



This all-plastic milk float, manufactured by Mickleover Transport Ltd., for United Dairies, employs **deeglas** chopped strand mat as its sole reinforcing material.



All **deeglas** products, chopped strand mat, glass rovings and deeformat, are produced under a quality control system based on the requirements of BS.600 and BS.600R. This ensures the consistency so essential for perfect mouldings. Chopped strand mat and deeformat, in standard and rooflighting grades. Glass rovings.

deeglas

Glass Yarns & Deeside Fabrics Ltd. 44-46 Kingsway, London, W.C.2

Telephone : Chancery 7343 and 8257

MIC 8202

S.T

MORART GRAVURE CORP.

HOLYOKE, MASSACHUSETTS — DAYTON, OHIO

INCORPORATED 1927

MULTI-COLOR GRAVURE PRINTING

DESIGNERS and CONVERTERS
of DECORATIVE PAPERS

SPECIAL DECORATIVE PAPERS FOR THE
LAMINATING TRADE

Reproduction of

WOODGRAINS

MARBLES

FABRICS

ART WORK

OTHER MATERIALS

ETCHED COPPER GRAVURE CYLINDERS

MORART-OXFORD CORP.

(Wholly owned subsidiary of Morart Gravure Corp.)

DAYTON, OHIO



THIS SYMBOL IS YOUR ASSURANCE OF QUALITY FIBER GLASS REINFORCED PLASTICS

Properly-made fiber glass products have unusual strength, light-weight, dielectric strength and high corrosion, heat and weather resistance. All this plus molded-in color, and such optional characteristics as translucency, flexibility and texture.

Fiber glass moldings can often reduce manufacturing costs by replacing a cast or fabricated part. "Fiber glass," with its magic appeal, can enhance the appearance of your product through freedom of design.

Since 1948, Structurlite has been helping scores of customers capitalize on the advantages of fiber glass molding in a wide range of products from safety hats to school furniture.

Our experience covers all types of resin and fiber applications. We can meet virtually any production requirement, and have facilities for finishing, assembling and packaging.

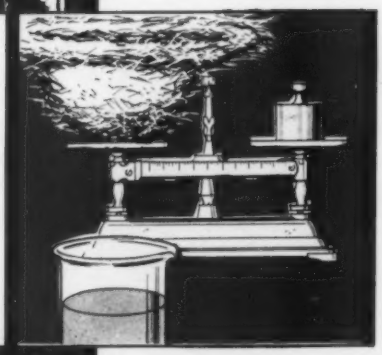
Throughout, quality is emphasized time and again—from selection of the best resins and fibers, to insistence upon careful workmanship, and a rigid quality control system.

A versatile battery of presses up to 500 ton capacity, automatic preforming machines, other equipment and methods have been designed to maintain the high standards of quality at the lowest possible costs.

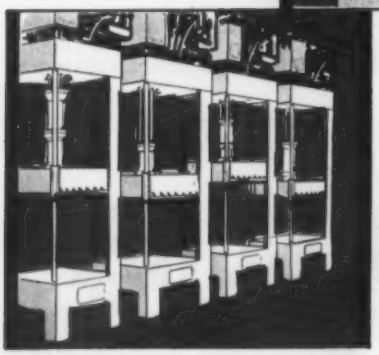
We invite an opportunity to discuss with you the application of fiber glass in your product or manufacturing operation. Write for illustrated brochure on significant fiber glass applications, pioneered by Structurlite.



Reliable Engineering



Quality Control



Mass Production Capacity

STRUCTURLITE
PLASTICS CORPORATION
123 Newark Road • Hebron, Ohio

The factory of EXPERIENCE in light weight structural plastic products



puts
the
plus
in
plastic
products

EXETER GLASS CLOTH

adding strength, lightness of weight, dimensional stability, heat-abrasion-corrosion-impact resistance to a new world of plastic products:

• GUIDED MISSILES • BOAT HULLS AND SUPERSTRUCTURES • AIRCRAFT FRAMES AND COMPONENTS • ELECTRICAL INSULATION • INSECT SCREENING • TOOLS, DIES, JIGS AND FIXTURES

EXETER MANUFACTURING COMPANY, Est. 1871
INDUSTRIAL GLASS CLOTH DIVISION
SALES: 40 Worth Street, New York 13, N. Y., Tel. WOrth 4-3440; *MILL and FINISHING PLANT:* Exeter, N. H.

IN BASIC MATERIALS . . . CHOOSE FROM THE

INDUSTRY'S BROADEST LINE... over 100 grades

PHENOLITE® LAMINATED PLASTIC

SHEETS • RODS • TUBES • FABRICATED PARTS

A thermosetting high pressure laminate combining exceptional strength, moisture resistance and lightness of weight with excellent electrical, thermal and chemical properties. Available in over 80 standard and special grades each with a unique combination of properties. Application base—practically unlimited.

CODE: E—Excellent G—Good F—Fair P—Poor — PHENOLITE LAMINATED PLASTICS

	PROPERTIES	X-116-AP	X-N-152	P-214-B	PC-208-D	XX-324-P	XXP-209-G	XXX-409-P	XXXP-455	E-2040	Y-2500	C-501-P	MCB-531-A	GE-575-P	L-610-P
ELECTRICAL	Dielectric strength—Perpendicular to laminations (500 volt per mil on 1/16" = G)	E	E	G	G	E	E	G	E	G	G	P	P	G	P
	Dielectric strength—Parallel to laminations (50 KV = G)	P	P	G	P	G	E	E	E	E	F	P	P	G	P
	Dielectric losses	P	P	F	P	G	G	E	E	E	G	P	P	F	P
	Insulation resistance	P	P	F	P	F	G	G	E	E	F	P	P	P	P
	Arc resistance	P	P	P	P	P	P	P	P	P	G	P	G	P	P
	Electrical Stability—Humid Conditions	P	P	F	F	G	G	E	E	E	G	P	P	G	P
MECHANICAL	Tensile Strength (15,000 psi = G)	G	G	F	P	G	F	F	G	G	G	F	F	F	F
	Flexural Strength (20,000 psi = G)	G	G	F	P	F	F	F	G	G	F	G	G	G	G
	Compressive Strength (30,000 psi = G)	G	G	F	F	G	F	G	F	F	G	G	E	G	G
	Impact Strength (1.0 ft. lbs. = G)	G	G	F	F	F	F	F	F	F	F	G	G	G	G
	Bond Strength	G	G	F	P	G	F	G	F	F	G	E	E	E	E
PHYSICAL	Water Absorption	P	P	F	F	G	G	E	E	E	G	F	F	G	F
	Dimensional Stability—Humid Conditions	P	P	F	F	G	G	E	E	E	G	F	F	G	F
	Heat Resistance	F	F	F	P	G	F	G	F	F	G	F	F	G	F
CHEMICAL	Acid Resistance	F	F	F	F	F	F	G	G	G	F	F	F	G	F
	Alkali Resistance	P	P	P	P	P	P	P	P	P	F	P	G	P	P
	Organic Solvent Resistance	F	P	P	P	G	F	E	F	F	G	G	G	G	G
GENERAL	Base Material	Kraft Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Paper	Cotton Fabric	Cotton Fabric	Cotton Fabric	Cotton Fabric
	Type of Resin	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Modified Phenolic	Phenolic	Melamine	Phenolic	Phenolic
	AIEE Insulation Class	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Comparative Price	.7	.6	.8	.8	1.0	1.0	1.1	1.2	1.0	1.2	1.4	1.6	1.4	1.7

NEW MATERIALS CATALOG



For full technical engineering and property data on all National basic materials—request new 16-page catalog. Write Dept. I. I.

NEW FABRICATED PARTS BOOKLET



Request National's new booklet—Fabricated Parts and Components. Write Dept. I. I.

COPPER-CLAD PHENOLITE CATALOG



For full data on National Copper-Clad PHENOLITE—request National's new catalog—Copper-Clad PHENOLITE. Write Dept. I. I.

NATIONAL VULCANIZED FIBRE

SHEETS • RODS • TUBES • ROLLS • COILS
FABRICATED PARTS

This low-cost material has excellent mechanical and good dielectric strength, unique arc expulsion properties, excellent machining and forming qualities. It is smooth, durable and light-weight. It is manufactured in many grades and forms with varying degrees of hardness, flexibility, resilience, drawing, forming and punching qualities.

NATIONAL NYLON

EXTRUDED ROD • FABRICATED PARTS

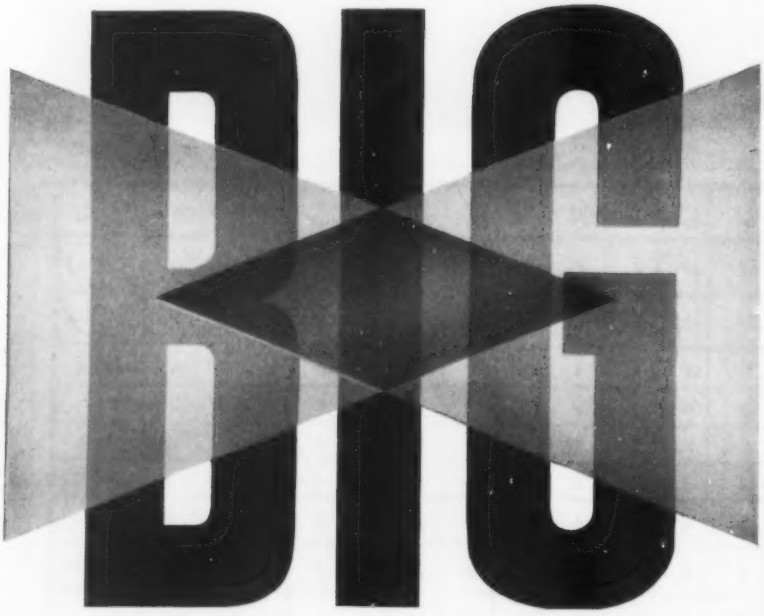
A superior thermoplastic combining good mechanical and electrical properties with excellent chemical resistance. Its strength, low coefficient of friction and resistance to wear and abrasion is outstanding. Material advantages include low tooling costs, design flexibility, close tolerance machining, low cost pilot runs, immediate availability.

																	VULCANIZED FIBRE			NATIONAL NYLON	
LE-675-P	A-703-P	AA-761-A	AAA-746	N-[illegible]952	K-2180	G-1-881	G-3-821	G-5-813	G-6-833-A	G-7-832	G-8-881	G-10-865	GP-9180-A	GP-9184	GP-9282	GP-9284	Commercial	Base	Peerless	N-31	N-101
G	F	P	P	G	P	F	E	G	F	F	F	E	F	F	G	F	F	F	F	G	F
G	P	P	P	E	P	P	F	F	G	G	G	G	G	G	G	G	G	G	G	—	—
F	P	P	P	G	P	G	G	G	E	E	G	E	F	G	G	G	P	P	P	E	G
P	P	P	P	E	P	P	F	F	F	G	P	E	P	P	P	P	P	P	P	—	—
P	P	P	P	P	P	P	P	E	E	E	E	E	G	G	P	E	E	E	E	G	G
G	F	P	P	E	P	F	F	G	E	E	G	E	G	F	G	G	P	P	P	F	G
F	F	F	E	P	G	F	E	E	G	E	G	E	G	G	G	G	P	F	F	F	G
G	G	G	G	F	G	E	E	E	G	E	G	E	G	G	G	G	P	F	P	P	P
G	E	E	E	P	E	E	E	E	E	E	E	E	E	E	E	E	G	E	G	P	P
G	G	G	G	G	G	E	E	E	E	E	E	E	E	E	E	E	G	G	E	G	G
E	F	E	G	G	P	G	G	E	G	P	E	E	G	G	G	G	G	G	G	—	—
G	F	P	F	E	F	F	F	G	E	E	F	E	G	G	G	G	P	P	P	G	F
G	F	P	F	E	F	F	F	G	E	E	F	E	G	G	G	G	P	P	P	G	F
G	G	G	G	P	F	G	G	G	E	E	G	G	G	G	G	G	P	P	P	P	P
G	F	F	F	G	F	F	F	P	G	G	F	G	G	G	G	G	P	P	P	F	F
F	P	P	P	F	P	P	P	G	G	G	G	G	F	F	F	F	P	P	P	G	G
G	G	G	G	G	G	G	G	G	P	P	G	G	G	G	G	G	E	E	E	G	G
Cotton Fabric	Asbestos Paper	Asbestos Fabric	Asbestos Mat	Nylon Cloth	Cotton Mat	Staple Glass Fabric	Cont. Glass Fabric	Cont. Glass Fabric	Staple Glass Fabric	Cont. Glass Fabric	Glass Mat	Cont. Glass Cloth	Glass Mat	Glass Mat	Glass Mat	Glass Mat	Cotton Paper	Cotton Paper	Cotton Paper	—	—
Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Phenolic	Melamine	Silicone	Silicone	Melamine	Epoxy	Polyester	Polyester	Polyester	Polyester	—	—	—	ZYTEL 31	ZYTEL 101
A	B	B	B	A	A	B	B	B	H	H	B	B	B	B	B	B	A	A	A	A	A
1.7	1.1	2.7	2.0	3.7	1.4	2.0	2.7	2.4	6.7	6.7	1.8	3.7	0.9	.8	1.8	1.2	.4	.4	.4		

PHENOLITE STOCK PLAN—PHENOLITE sheet now available from stock for immediate delivery. Your nearby National Sales office can furnish you fast, accurate information on grades, sizes and costs.
Check your local National Sales Office.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

OUR PLASTIC SHEETING IS



Specializing in the largest rigid plastic laminated sheeting, Laminations, Inc. is prepared to tailor its BIG sheets to your most exacting specifications.

These big sheets are produced in most any material, especially in vinyl and polyethylene, in pressed polished or matte finishes on both sides or in combination—one side pressed polished, the other side matte. Thicknesses: 5 mils to 1 inch. Sheets have flawless surfaces and require only a minimum of trimming.

In answer to an ever increasing demand, Laminations, Inc., combines quality with bigness.

High and low impact p. v. c. **Sizes: to 54" x 120"**

PRESS POLISHED
sheets for graphic arts applications in sizes to 54" x 120"

EMBOSSED
sheets for structural and decorative uses in sizes to 48" x 144"

LAMINATED
sheets with paper, fabric and other embedments in sizes to 54" x 120"

LAMINATIONS, INC.

1008 S. IRVING AVENUE SCRANTON, PENNSYLVANIA

Diamond 3-7921

Quick Quiz

for suppliers of plastics packaging and plastics packaging materials

Q. What's the most effective magazine for advertising to men who buy packaging supplies?

A. Judged by the votes of the men who should know best—the companies and advertising agencies who back their opinions with advertising appropriations—*Modern Packaging* is far and away the most powerful and influential medium. In 1956, *Modern Packaging* carried the advertising of 96% *more* packaging suppliers than the second-place publication!

Q. Which packaging magazine provides the greatest amount of helpful editorial material and how-to-do-it information for its subscribers?

A. *Modern Packaging* routinely carries more than twice as many pages of editorial matter as any of the other publications in the packaging field.

Q. Which packaging magazine presents the greatest volume of advertising?

A. In 1956 *Modern Packaging* carried 2,185 pages of advertising as aganist 1,154 for the second place publication.

Q. Which magazine do buyers of packaging find most useful?

A. At the 1957 National Packaging Exposition sponsored by the American Management Association, an independently conducted survey of exposition visitors showed that *Modern Packaging was voted "most useful" by a 2½-to-1 ratio over the second-ranking periodical.*

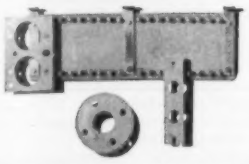
If you make anything that packagers buy, you'll want to know more about *Modern Packaging*, as an advertising medium; whom it reaches, how it stimulates buying action, how much is costs to deliver your sales messages in it. Just write to Advertising Department, *Modern Packaging* magazine, 575 Madison Avenue, New York 22, N. Y.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Keuffel COMPANY NEWARK 29, DELAWARE

HELPS YOU IMPROVE DESIGN
HELPS YOU SIMPLIFY PURCHASING
HELPS YOU SPEED PRODUCTION

DILECTO LAMINATED PLASTICS



POST-FORMING: Certain Dilecto grades (CF-1, XF, and XF-FR) may be formed to special shapes by heating and placing in an inexpensve cold mold. The thermoelastic properties of these Dilecto laminates open many production and design opportunities. Already widely used by the aircraft and switchgear industries, Post-Forming Dilecto merits full investigation by every alert manufacturer. Write for complete C-D-F engineering service.

DILECTO ROLLED OR MOLDED TUBING finds wide usage in radio and electrical equipment because of excellent insulating and mechanical properties. Impregnated paper or fabric is rolled on a mandrel between heated pressure rolls, then oven baked or press cured in a heated mold to set up the resin.

Dilecto meets the need for a non-metallic lightweight insulating material that is moisture resistant, good electrically, strong and adaptable to all fabricating operations. Some grades have exceptionally high mechanical strength—tensile, flexural, impact; others have flame resistance, high dielectric strength, high insulation resistance, high arc resistance and low loss factor.

Dilecto is a laminated material made from a base of either cellulosic paper; heavy or fine weave woven cotton fabric or mat; asbestos paper, woven asbestos fabric or mat; woven glass fabric or mat; and is coated with a synthetic resin.

The selection of the proper base material, the proper resin in the correct proportion, is C-D-F's job, but the end user must realize how important it is that he fully understands what dividend results can be gained mechanically, and electrically, and from a cost standpoint, by getting the very best C-D-F material for the project. Here is a brief, yet complete listing of Dilecto sheet grades, each one with a combination of proven characteristics built into the material for the specific job.

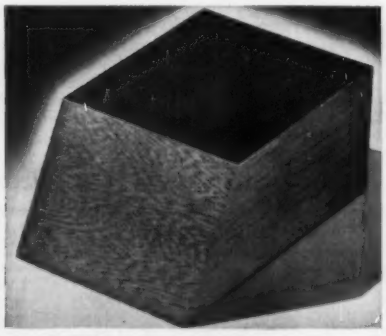
SHEET GRADE CLASSIFICATION (Rod and Tubing similar to sheet stock)

- X For mechanical applications when electrical properties are secondary.
- P For punching (paper-based grades).
- XX For electrical applications requiring mechanical strength.
- XXX For high humidity applications with minimum cold flow.
- L For mechanical applications requiring fine machining.
- C For mechanical applications requiring toughness plus impact strength. For chemical and special uses.
- CE and LE For electrical uses requiring greater toughness than paper-based grades.
- GB For applications requiring heat resistance and high mechanical strength. Supplied in combination with phenolic, silicone, melamine, polyester, epoxy, or Teflon resin.

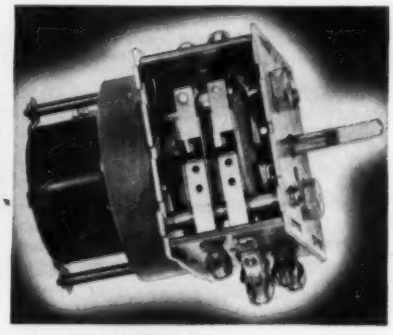
Note: Various C-D-F grades, identified by numbers affixed to the grade classification, are available. Ask for catalog.



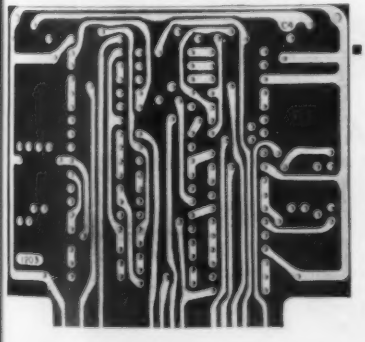
VERSATILE is the word for Dilecto. Sheets, tubes, rods, fabricated specialties can be furnished rapidly at low cost for difficult jobs. Write for new complete Dilecto catalog, and send us your print for quotation.



DILECTO is almost homogeneous and has been made using the latest advances in resin and laminating techniques. It is easily machined, is always uniform in nature . . . a quality basic material with many uses.



A GOOD SWITCH like this relies on dependable electrical insulation. C-D-F sales engineers work with the designer, helping him get the best materials at the lowest cost. Why not call us in on your product problem?



METAL CLADS FOR PRINTED CIRCUITS

The selection of metal-clad stock for printed circuit applications depends often upon the stability and uniformity of the core material. C-D-F offers the designer and production engineer a working range from low-cost phenolic stock to a Teflon glass-based laminate with resistance to extreme temperatures. Also, C-D-F can offer higher and better bond strengths because of improved laminating techniques and the use of the latest bonding methods. For complete specifications, sheet sizes, write for Metal-Clad Folder and samples.

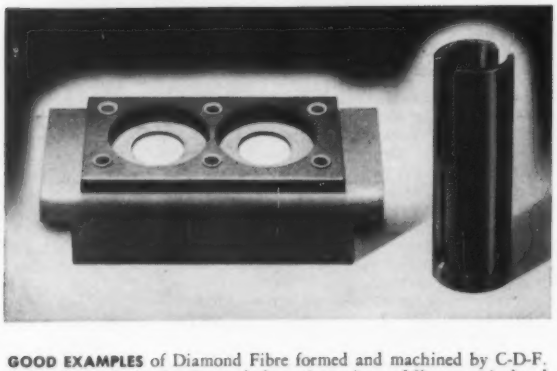
DILECTO Metal-Clads—Most practical grades are Dilecto XXXP-26 and XXXP-28, phenolic paper-based laminates with high moisture-resistance and excellent electrical properties. Also, copper-clad epoxy glass-fabric laminate.

TEFLON Metal-Clads—Glass fiber cloth with Du Pont's Teflon resin. Outstanding resistance to high heat with low dielectric loss properties. Write for samples.

CONTINENTAL DIAMOND FIBRE

. . . C-D-F IS A BIG, RELIABLE SOURCE FOR MANY FABRICATED AND FORMED

VULCANIZED FIBRE



GOOD EXAMPLES of Diamond Fibre formed and machined by C-D-F. Left—An insulating barrier made from three pieces of fibre, punched and formed. Fibre tubing is even used for rivets. Right—A fibre tube which has been smooth-sawed to length, punched twice and countersunk. C-D-F can handle the entire job for you, do it faster and at low cost. This includes selecting and testing the proper grade of fibre, machining and inspection, assembling if needed.

If your job is to select a general-purpose insulating material that is low cost, useful for both electrical and mechanical applications, easy to machine and form, consider the advantages of a unique old-timer—C-D-F's Diamond Vulcanized Fibre.

WHAT IS FIBRE? Vulcanized fibre is made by combining layers of chemically jelled paper. The chemical compound used in gelling the paper is subsequently removed by leaching and the resulting product, after being dried and finished by calendering, is a dense material of partially regenerated cellulose in which the fibrous structure is retained in varying degrees, depending upon the grade of fibre. —NEMA Standard VU 1-1.1

GOOD ELECTRICALLY. Although given a modest insulation rating for resistance to heat (A.I.E.E. Class A with a temperature limit of 221° F.), Diamond Fibre is often used because of its excellent arc resistance and good dielectric strength. It also has desirable deionizing properties and low heat conductivity. Fibre can be combined or surrounded with moisture-resistant laminated plastic.

MANY GRADES AND FORMS. Diamond Fibre sheet and mill grades include Bone, Commerical, and Electrical Insulation (fish paper) NEMA grades. Fibre tubing is normally made only in Bone grade, with rods available in both Bone and Commercial grades. The chart shown outlines the major characteristics of these grades.

C-D-F BONE FIBRE	Hard, stiffest grade. High density. Resists wear, abrasion, has high compressive strength. Good dielectric strength when dry. Super machining qualities. Not recommended for bending.
C-D-F COMMERCIAL FIBRE	Mechanical and electrical grade. Medium density. Tough, pliable. Good mechanical properties. Fair dielectric strength, normally high when dry. Can be bent, punched, and formed.
C-D-F DIAMOND INSULATION	Electrical insulation "fish paper" grade. Unusually free from foreign matter. Withstands extreme bending and forming without cracking. High dielectric strength, except under high humidity.

TOUGH, RESILIENT, STRONG. How long has it been since you examined the unique properties and wide range of C-D-F fibre grades? Vulcanized Fibre is arc resistant, mechanically strong, non-corroding, half the weight of aluminum. Repeated moistening and drying in forming insignificantly alters the nature, structure or quality of the fibre.

A BIG, RELIABLE SOURCE. C-D-F does business with the largest tonnage users of sheet, rod and tube fibre in the world. This means good deliveries, good prices, reliable products for every new customer. You deal with a materials engineer, a C-D-F man who knows how to give you the most value in Diamond Vulcanized Fibre. If you want to improve design, simplify purchasing, speed production, use Diamond Fibre and the facilities of C-D-F. Write for new Diamond Fibre catalog and free test samples, or send us your print for quotation.

MECHANICAL PROPERTIES OF DIAMOND VULCANIZED FIBRE

Property	Sheet thickness, tube wall or rod diameter	SHEETS Bone CW	SHEETS Bone LW	SHEETS Commercial CW	SHEETS Commercial LW	TUBES	RODS Bone	RODS Commercial
Tensile Strength	Up to 1/8"	6500	8500	6000	8000	6500	8500	8000
	Over 1/8 to 1/2	6000	8000	5500	7500	6500	8000	7500
	Over 1/2	....	....	5000	7000	6500	....	7000
Flexural Strength	Up to 1/2"	13,000	15,000	12,000	14,000		15,000	14,000
	Over 1/2	....	....	11,000	13,000		....	13,000
Compressive & Axial Strengths	Up to 1/8"					10,000		
	Over 1/8 to 1/4					9000		
	All thicknesses or diameters	30,000		20,000			8000	6,000

NOTE—* Tensile strength only.

VULCOID — RESIN-IMPREGNATED FIBRE

Only C-D-F supplies Vulcoid in sheets, tubes, rods, and fabricated parts. Made from Diamond Vulcanized Fibre that has been uniformly impregnated with a special resin, Vulcoid is a material approved and identified by the Underwriters' Laboratories as Class A Insulation. Natural greenish-tan in color, it is economical, easy to machine and punch. Property-wise, Vulcoid is an intermediate grade between Commerical Fibre and XX phenolic Dilecto.

USES: (requiring arc resistance and mechanical strength)—contact and connector panels, knife switch arms and guides, arc deflector spacer bushings; (requiring dielectric strength and moisture resistance)—electrical fixture insulation, wiring devices, plugs, receptacles; (requiring moisture and arc resistance)—motor and transformer lead bushings and terminal blocks. Write for folder V-55, and test samples.

CONTINENTAL DIAMOND FIBRE

MODERN PLASTICS THAT HELP INDUSTRIES SAVE MONEY!

TEFLON — HIGH HEAT INSULATION

OUTSTANDING PROPERTIES

HEAT RESISTANCE: Due to the non-flammability and high heat resistance of Teflon,* it easily meets both Class B and Class H, AIEE standards for maximum hot spot insulation temperature. Teflon-coated glass fabric laminates withstand 250° C. continuously and up to 300° C. intermittently. One factor which influences the heat resistance of Teflon is that there is no apparent degradation from oxygen, which has a definite degrading effect on silicone materials.

*Du Pont Trademark

MOISTURE RESISTANCE: A Teflon laminate has practically zero water absorption and its electrical properties are little affected after long exposure to high humidity. Teflon is unaffected by fungus and temperature changes. Not only has it lower moisture absorption than any other laminate known, but it tends to repel water . . . retaining high surface insulation resistance properties even under extreme humidity conditions.

FORMS: C-D-F molds, machines and processes Teflon into the forms you need . . . *unsupported* or pure Teflon sheets and tapes, glass-fiber cloth *supported* sheets and tapes, metal clad stock for printed circuits, diaphragm sheet stock, gaskets, packing, release materials, tubes and rods.

NEW CEMENTABLE TEFLON: CDF now offers unsupported and glass-supported Teflon in sheets and tapes with the added advantage of being readily cementable to itself or to other materials with commercial adhesives. Treated usually on one side only, the Teflon retains its unique mechanical and electrical properties on the untreated side and modifies the treated side to a surface that accepts adhesives and bonds readily. Write for full technical data.

DIELECTRIC STRENGTH: The dissipation factor and dielectric constant of Teflon laminates are both extremely low over a wide frequency range. From 60 to 100 megacycles. the dissipation factor range is between .005 and .0005, and the dielectric constant ranges from 2.8 to 2.5 when measured in a field perpendicular to laminations. As corona will slightly degrade Teflon, care should be taken in designing parts used at voltages over 2500. Sharp corners and other contributing factors to corona should be avoided.

CHEMICAL INERTNESS: Resistant to hot corrosive salts and most concentrated acids. Pure Teflon is unaffected by all known chemical agents, excepting molten alkali metals and, under special conditions, fluorine and chlorine trifluoride. Glass-supported Teflon, when exposed at cut edges, is affected only by those chemicals which attack glass. Otherwise, its properties remain the same.

Write now for Technical Folder. Call your C-D-F sales engineer who will explain C-D-F's technical and production facilities for providing you with Teflon . . . industry's most promising plastic!

SPIRAL TUBING



GOOD DIELECTRIC STRENGTH
LOW DIELECTRIC LOSS PROPERTIES
GOOD MECHANICAL STRENGTH AND MOISTURE RESISTANCE

C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating. Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14" to take .248" to .250" core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples. Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores. C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information. Write for folder.

C-D-F SPIRAL TUBING SELECTOR CHART

AVAILABLE GRADES

IMPREGNATED

- .1 General Electrical and Mechanical Grade. ○
- 1A Electrical and Mechanical Grade—Special Punching. ○
- 2 Mild Stapling, Riveting, and Post Forming Quality. ○
- 2A Intermediate Fabricating and Stapling Quality. ○
- 3 Severe Stapling, Riveting, and Post Forming Quality. ○
- 5 Constant Torque and Formed-to-Shape Coil Form Tubing. △ ⏚
- 6 Special for High Humidity Applications. ○
- 6A Extra Hard, High Strength Tubing. ○
- 7 Soft Varnished Kraft Tubing. ○ □ ▭
- 7A Hard, Rigid Rectangular Tubing. □ ▭
- 8 Varnished Diamond Insulation—Tubing. ○
- 9 "Deflection Coil" Tubing. ○
- 10 Larger Size, Heavy Wall Tubing for Mechanical Uses. ○

UNIMPREGNATED

- 20 Special Wound in Specified Combinations of kraft paper, fish paper, etc. ○ □ ▭
- 21 Plain Kraft Paper Tubing. ○ □ ▭
- 22 Plain Diamond Insulation Tubing. ○
- 23 Plain Chipboard Tubing. ○

○ Round — ⏚ Formed and Notched
△ Formed (fluted shape) — □ ▭ Square, Rectangular

MICABOND



C-D-F has special know-how, extensive plant for producing superior mica insulation. Only the finest mica splittings are used; coverage is completely leak-proof with improved strong binders used. America's largest users of mica products rely on C-D-F for uniform, high-quality Micabond tapes, sheets, segments, tubing, "V" rings, slot liners. To build a better motor, to get more insulation value, specify Micabond. Write for new Micabond catalog M-55, samples, technical aid.

CONTINENTAL DIAMOND FIBRE

PLASTICS FOR EVERY PURPOSE FROM ONE BIG SOURCE

FLEXIBLE INSULATION

THREE HIGH-HEAT TAPES



C-D-F SILICONE TAPES for AIEE Class H Electrical Insulation. Available in varnished glass-fiber cloth and silicone rubber-coated glass-fiber cloth. Resistant to high temperatures. High dielectric strength. Write for Technical Bulletins #47 and #52 and new Flexible Insulation catalog.

C-D-F TAPES OF TEFLON* withstand 500°F. Practically zero water absorption. Sold in 100% Teflon film or Teflon glass-fabric-supported. Used for wrapping field coils, wrapping cables subject to abrasion of undertar blast. Write for Folder and samples. New *cementable* tapes of Teflon (see previous page for details) make the use of flexible insulations of Teflon even easier.

C-D-F MICABOND TAPES are used for insulating motor and generator armature and field coils. Flexible. Wide range of sizes and backings. Write for new Micabond Catalog. Call the C-D-F sales engineer listed below—he's a good man to know!

*Du Pont trademark

CELORON

MOLDED INDUSTRIAL PLASTICS

Celoron of laminated or molded-macerated cotton fabric-base construction is used extensively for industrial and automotive timing gears. Celoron molded-macerated cotton fabric or paper is used for many mechanical and structural electrical applications. Celoron is unaffected by rapid temperature changes, may be used continuously at 225 to 250°F. It has high impact strength, excellent resistance to heat, oil and water, many chemicals. Both laminated or molded Celoron is easily machined.

SHEETS

From laminated stock, fabric-based phenolic-impregnated Celoron can be furnished in sheets, cut pieces, blanks and rings machined from sheet stock. For gear applications (idler and spur gears, and cams), it is normally identified by two black lines. See Dilecto C grades for mechanical applications requiring toughness plus impact strength.

MOLDED

Celoron can be molded to close tolerances for both mechanical and electrical applications. Rugged, dimensionally stable, readily machined, Celoron is a dependable material; remember C-D-F has both the men and equipment to handle "big run" molding requirements.

Colors: Golden mottled brown or black.



GEARS

These gears, pulleys and discs are all Celoron which finds wide usage in textile and printing machinery. Build silence into your product with Celoron gears. Write for Celoron catalog with horsepower ratings.



INSULATION

This diesel contact controller drum assembly uses two C-D-F products: Celoron drum body, drilled and broached, Diamond Vulcanized Fibre between fingers of the brass contact plate.

SALES OFFICES

BALTIMORE 14, MD. NOrthfield 5-0964
2451 Ellis Road
BIRMINGHAM 6, ALA. VErnon 3-5713
110 95th St., N.
BOSTON SALES OFFICE Granite 2-2150
1245 Hancock St., Quincy 69, Mass.
BUFFALO 3, N.Y. WAshington 3929
495 Ellicott Square Building
CHICAGO 11, ILL. DElaware 7-6266
1201 Palmolive Building
CLEVELAND 14, OHIO Cherry 1-5220
550 Leader Building
DAYTON 2, OHIO Adams 4291
221 Third National Building
DENVER 2, COLO. AComa 2-2236
260 Denver Club Bldg.
DETROIT 35, MICH. BRoadway 3-0447
201 Offcenter Bldg.
FT. WORTH 7, TEXAS Fannin 3339
3414 Camp Bowie
GREENSBORO, N.C. 4-0226
2103 Mimosa Drive
HARTFORD SALES OFFICE
Hartford-Jackson 9-0397
15 Harding St., Wethersfield 9, Conn.
HOUSTON 4, TEXAS JAckson 3-9254
2311 Travis Street
INDIANAPOLIS 5, IND. WAlnut 5-9803
709 E. 38th Street
KANSAS CITY 11, MO. Logan 6014
406 W. 34th St., Room 11
MILWAUKEE 2, WIS. BRoadway 1-2980
828 N. Broadway
EXPORT DEPARTMENT: BRIDGEPORT, PENNSYLVANIA, U.S.A.
MINNEAPOLIS 2, MINN. Federal 3-3388
610 Plymouth Bldg.
NEW YORK 17, N.Y. Murray Hill 6-0870
290 Madison Avenue, Room 501
OMAHA 3, NEBR. ATlantic 6348
110 North 40th Street
PHILA. DISTRICT SALES OFFICE
Bridgeport, Pa. Broadway 5-0800
PHOENIX, ARIZONA ALpine 8-7893
P. O. Box 1587
PITTSBURGH 21, PA. Churchill 1-0969
309 Shields Bldg.
ST. LOUIS 17, MO. Mission 5-2253
2683 Big Bend Blvd.
SPARTANBURG, S.C. Spartanburg 3-6397
834 Hayne St.
TULSA, OKLA. 5-6189
204 S. Cheyenne St.

Pacific Coast Representatives
MARWOOD LIMITED
SAN FRANCISCO 3, CAL. Hemlock 1-7893
357 Ninth Street
SEATTLE 4, WASH. Elliot 4747
1714 First Avenue, South
PORTLAND 4, ORE. CApital 3-5123
209 S. W. First Avenue
LOS ANGELES 13, CAL. Mutual 3241
320 East 3rd Street

Canadian Representative
DIAMOND STATE FIBRE CO. OF CANADA, LTD.
46 Hollinger Rd., Toronto 13, Ontario, Can.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Bird COMPANY NEWARK 29, DELAWARE

New IMPROVED PAPERS *for* DECORATIVE *and* INDUSTRIAL LAMINATES





Constant research and evolution now enable us to produce new and improved papers for decorative laminates. These new offerings to the laminating industry include:

1. **Lighter Weight Print Base Papers** having the same range of opacity as the earlier types. Very worthwhile savings accrue through the use of these high opacity lighter base weight papers.

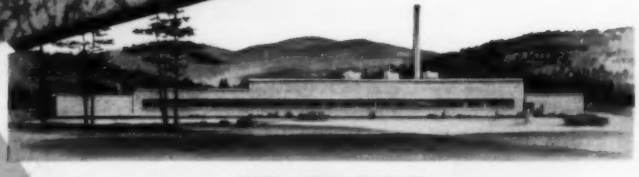
You save paper cost
save resin cost
save freight cost
save storage space

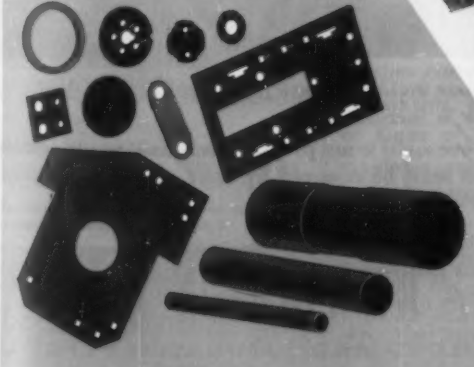
In addition laminates with less tendency to warp are possible.

2. **Improved white overlays**

3. **Metallic inclusions** in transparent overlay for sparkle effect.

Samples on request.





OUR NEW PLANT
Now under construction will double our present production capacity.

HURLBUT
PAPER COMPANY
SOUTH LEE, MASSACHUSETTS



... better molded parts because of

1200 years of tool and die experience

At least 50% of getting a good molded part depends on the quality of your mold.

One hundred Richardson men have more than 1,200 years combined experience in the design and production of tools and dies for the production of molded plastic parts. They provide the broad and varied experience needed for the design and production of quality molds to close tolerances.

The men who make Richardson molds know and respect the many "ifs" encountered in the design and production of quality molds. They know that . . .

. . . if your mold isn't correctly designed, the resulting parts will not be according to specifications.

. . . if your mold is not properly designed, the parts cannot be ejected quickly, production speed will be reduced, and unit cost increased.



The Richardson mold and die shop at Melrose Park, Illinois, is one of the largest in the plastics industry.

. . . if your mold walls are not of uniform thickness, curing time is increased.

. . . if your mold is not properly designed, resulting excessive flash must be removed by hand . . . a costly procedure.



Richardson engineers can assist your engineers in (1) redesigning parts for conversion from other materials to molded plastics, and (2) designing to improve molded parts now in production.

For additional information and a copy of the newly published catalog, "Richardson Molded Plastics," write or phone, today . . . Chicago number, MAnsfield 6-8900.

The RICHARDSON COMPANY

MOLDED AND LAMINATED PLASTICS

. . . better plastics for better parts

Dept. 17, 2747 Lake St., Melrose Park, Illinois

Parkwood

high-pressure laminates

Manufacturing under the highest pressures that it is desirable to use, Parkwood adheres to meticulous laboratory controls and production techniques; meets or exceeds the highest standards of the industry.

INDUSTRIAL LAMINATES

HI-DEN (Parkwood's trade name for densified wood) — a laminate of carefully selected birch veneers, impregnated with phenolic resins. Hi-Den is a homogeneous material of extreme density, strength, moisture resistance and dimensional stability.

Available in several grades, in panels up to 2" thick and varying widths and lengths, Hi-Den can be machined to close tolerances with high-speed woodworking tools, belt or disc sanders and buffed to a high polish.

Used successfully for picker sticks, strain insulators, power sticks, forming and drawing dies for light metal, its beautiful natural wood grain has also made it a favorite material for cutlery and other handles, clarinets, store fixtures, architectural hardware, etc.

Our engineers will be glad to work with you on specific problems. For illustrated Hi-Den brochure, price list, etc., write Dept. H.

PARKWOOD 8000 — a kraft paper impregnated laminate of great density and stability. Especially recommended for flat thin applications such as bench tops or routing templates, fixtures and some types of Hydro-form dies.

DECORATIVE LAMINATES

for Duty, for Beauty

Parkwood decorative panels offer architects, designers and fabricators maximum quality, range, flexibility and long-run economy. Protected for life by genuine Melamine — unsurpassed for appearance, feel, and resistance to abrasion.

DECORATIVE Parkwood does the top styling job of the industry in this group, with many smart patterns and the finest and largest selection of plain colors available anywhere.

GENUWOOD High-pressure laminate incorporating a layer of *genuine* precious-wood veneer — the ultimate in surfacing for fine furniture, bars, counters, store fixtures.

ROTOWOOD Authentic reproductions of beautiful natural wood grain brought to a high degree of perfection by Parkwood's years of experience with wood veneers.

SUPERWOOD A premium Rotowood featuring exclusive multi-color reproduction of selected wood grains at a slight advance in price.

For handsomely illustrated brochure, samples, and name of nearest distributor, write Dept. D.

Parkwood Laminates, INC.

30 WATER ST., WAKEFIELD, MASS.

How to figure your sales potential in the plastics field



FREE . . . 40-page brochure will help you find answers to your questions about sales opportunities in the fast-growing plastics field.

THIS NEW STUDY contains the inside story of one of America's fastest growing industrial markets. It presents one of the most stimulating and detailed analyses of the plastics field that has yet been published. It's filled with up-to-date figures on the consumption and production of plastics materials, on the field's processing equipment requirements, on potential areas of growth. It lists hundreds of kinds of machines, accessories, chemicals and intermediates, supplies and special services for which the field is manifesting an ever-increasing appetite.

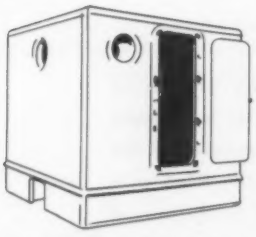
You will find this handsome brochure—file size, lavishly illustrated, 40-pages—a valuable addition to your business library. It may well point the way to increased sales for the industrial products or services that your firm supplies.

For your free copy of "The Plastics Field," simply address a note on your company letterhead to *Advertising Manager*, Modern Plastics, 575 Madison Avenue, New York 22.



AIRCOMB *may be your solution, too!*

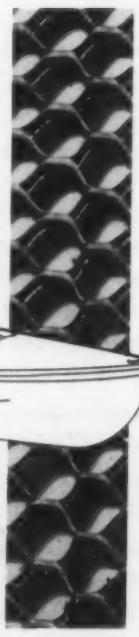
TRADE MARK



AIRCOMB SEA CABIN



AIRCOMB-HULLED BOAT



DOUGLAS

The high standards set for the "Monsanto House of the Future" made the selection of the finest materials imperative. Douglas AIRCOMB – a phenolic Kraft honeycomb structure – was chosen as a primary structural element. Its great strength, rigidity and outstanding insulation properties made it ideal for use in ceilings, floors, interior partitions and sliding doors.

It will be worth the while of every plastics engineer and manufacturer to get the facts on this exceptional material. Small boat designers have been particularly interested in AIRCOMB's high strength to weight relationship and resistance to corrosion and have been using it extensively for hulls, decks and cabins.

Faced with glass laminates or plastics, AIRCOMB is potentially useful wherever the combination of high strength and light weight is desirable. It is guaranteed by Douglas to have uniform strength and rigidity.

Write for AIRCOMB brochure to:

AIRCOMB SECTION
DOUGLAS AIRCRAFT COMPANY, INC.
3000 Ocean Park Blvd.
Santa Monica, California

- **MELAMINE IMPREGNATED PAPERS** in a wide variety of patterns, wood grains, solid colors, and translucent overlay grades for durable decorative laminates. Available in rolls slit to width, sheeted, or die-cut to any shape required.

- **PHENOLIC IMPREGNATED PAPERS** for producing N.E.M.A. industrial grade laminates and molded parts for a wide range of electrical, mechanical, and structural applications. Precisely controlled processing assures uniformity of quality.

- **PHENOLIC IMPREGNATED FABRICS** such as cotton duck, cloth, and sheeting for high or low pressure molding. Available in grades to meet N.E.M.A. standards. Also used in producing gears, bearings, filters, helmets, and many other products.

FABRICON

PLASTIC IMPREGNATED MATERIALS

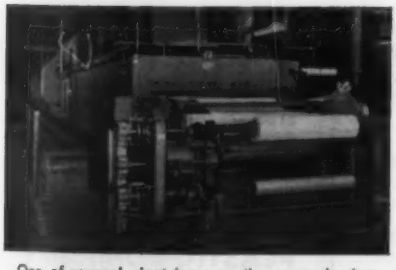
for Molding and Laminating

- **PHENOLIC IMPREGNATED GLASS CLOTH** produced in special grades for fabrication of fly rods, aircraft and guided missile parts, plus many other products requiring a strong, light, durable material highly resistant to heat and corrosion.

- **POLYESTER IMPREGNATED MATERIALS** such as glass fabric and mat for low pressure molding of aircraft parts, tools, and other applications where high strength, light weight, ease of forming, and dimensional stability are essential properties.

- **SILICONE IMPREGNATED GLASS CLOTH** in grades having excellent dielectric strength and resistance to distortion at high temperatures, plus other properties required for applications such as radar equipment, printed circuits, motors, etc.

- **EPOXY IMPREGNATED MATERIALS** custom treated to meet the highly specialized requirements of many electrical and electronic devices used for an ever-increasing number of military and industrial applications.



One of several giant impregnating ovens having roll capacities up to 90" in width. All are designed for continuous quality controlled operation.

Whenever you need plastic impregnated and coated materials, you'll do well *always* to think of Fabricon *first!* For regardless of what your requirements may be, you'll find that Fabricon has what it takes to deliver the quality and service that you've been looking for. Years of experience with all types of thermosetting resins and fillers. Complete engineering and laboratory facilities for developing new products and processes. Special production equipment designed for precisely controlled, continuous, economical operation. Facilities, too, for slitting material to width, sheeting, or die-cutting to any shape required.

Want detailed information on the Fabricon Plastic Impregnated Material that's *right* for your particular product? Just outline the nature of your application and send it in today!

FABRICON PRODUCTS

A Division of The EAGLE-PICHER Company

1721 W. Pleasant Street • River Rouge 18, Michigan

Plastic Impregnated and Coated Materials • Reinforced Plastic Moldings

WHY *Decarlite* IS THE FIRST CHOICE

high pressure decorative laminate

Fabricated in one of America's newest and most modern plants. Every operation skilfully controlled to produce the very finest laminates. Available in Four Basic Types

DECARLITE —The modern decorative plastic sheet laminate for surfacing dinettes, counters, bars, sink tops, furniture, school desks—wherever a durable, decorative surface is required. In many decorative designs and colors, including exclusive new wood-grains. Available in GLOSS or DULL RUBBED finish.

DECAFORM —Decorative DECARLITE in postforming grade. Can be formed to inside, or outside, contours by application of heat and forming pressure.

DECAFLEX —Decorative DECARLITE in a low caliper, formable grade for applications where bending at room temperature is required.

SUPER-DECABOARD—Decorative surfaced hardboard for applications requiring a rigid type panel such as occasional furniture, headboards, display panels, etc.

Made by

DECAR PLASTIC CORPORATION

Manufacturing

1212 N. Central Park Ave., Chicago 51, Illinois

1322 University Ave., Middleton, Wisconsin

---

it's nelco for "Know-How"

PLASTIC LAMINATES

In the production of *consistently*-high quality industrial-grade laminates for the electrical and electronics industries, Nelco's Know-How makes the finest possible use of unrivalled facilities for Research, Development, Production and Quality Control.

Unclad, or metal-clad on one or both sides, NELCO Laminates in thicknesses of 0.005" up—in sheets 36"x48", 36"x60", or 36"x72"—predictably meet the highest standards of the printed-circuit industry.

NELCO 100® and EPOGLAS® Epoxy-Glass-Cloth Laminates: for high strength, excellent dimensional stability and wet electrical-insulation properties, in electronic and printed-circuit applications.

NELCO 130 Epoxy-Paper Laminate: for excellent punchability and superior dimensional stability; no adverse effects from vapor degreasing.

NELCO 230 XXXP Phenolic-Paper Laminate: for superior cold-punching properties; especially well suited to printed-circuit applications in automated assembly.

FOR TECHNICAL DATA AND PRICES—Write To Department P

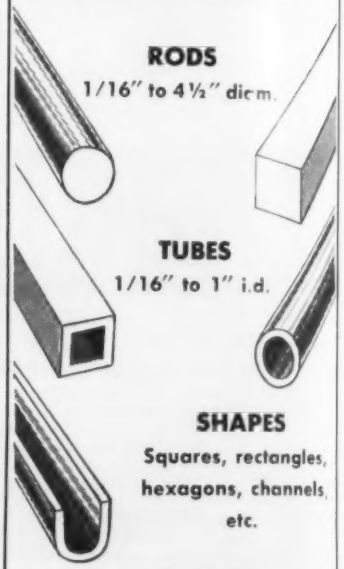
NEW ENGLAND LAMINATES CO., INC.

481 CANAL STREET • STAMFORD, • CONNECTICUT

DAvis 4-4181

POLYGON

Polyester and Epoxy EXTRUSIONS



RODS
1/16" to 4½" diam.

TUBES
1/16" to 1" i.d.

SHAPES
Squares, rectangles, hexagons, channels, etc.

Polygon extrusions are produced by a patented continuous process* which assures equal and continuous distribution of the tough reinforcing glass filaments and resin in each extrusion.

- tremendous strength
- excellent electrical properties
- controlled flexibility
- hardness
- low water absorption
- complete corrosion resistance

Polygon serves the electrical industry with many proven applications such as coil forms, motor wedges, spacers, selenium rectifiers, brush holders, relays, controls, strain bar insulators and many other uses.

Extrusions available in precision cut lengths or machined to specification.

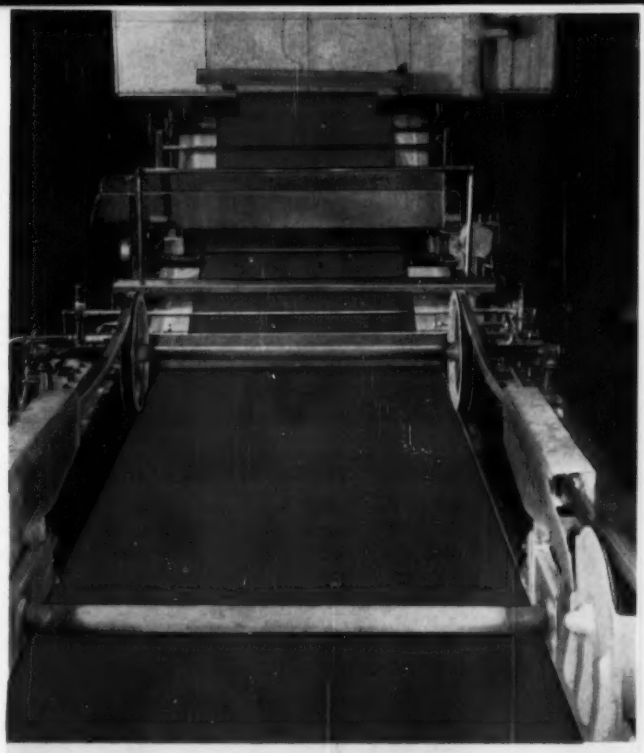
Send your print for quotation

POLYGON PLASTIC COMPANY
Walkerton, Indiana
Phone 169

*U.S. Patents No. 2,602,766; No. 2,684,318

Color O.K.!

The paper machine seen at the right is ready to run a large quantity of saturating paper for a leading manufacturer of laminated plastics. However, production won't start until a sample of the paper has been laminated in the Wrenn laboratory, to make certain that the color of the finished product will match the laminator's standard.



Leading laminators rely on WRENN for uniform quality and accurate color matching in SATURATING PAPERS



A modern, air-conditioned laboratory in the Wrenn mill is at the service of laminators who wish to write their own specifications for saturating and other absorbent paper. Technicians work in three shifts to develop products that will meet specified standards and to maintain quality control at every stage of production.

While color matching is of extreme importance in making saturating papers for decorative applications, it is only one of the many phases of quality control in the Wrenn mill. Other physical characteristics, such as basis weight, caliper, Mullen, density and absorbency, are carefully checked and must comply with accepted standards.

Samples of Wrenn saturating papers, for both decorative and industrial applications, will be gladly submitted on request.

THE WRENN PAPER COMPANY

Established 1858 — **MIDDLETOWN, OHIO**

Plaskon®

INDUSTRIAL RESINS . . . leaders in the field

Polyester resins for laminates

When reinforced with glass fibers, PLASKON Polyester Resins form high strength laminates that are lightweight, corrosive resistant, exceptionally versatile. Product advantages: high impact strength . . . hard, durable surface . . . molded-in color . . . dimensional stability. Rigid, resilient, and flexible formulations to meet specific end-product requirements.

Typical applications: Translucent panels, car bodies, modern furniture, safety helmets, luggage, boat hulls.

Polyester resins for pre-mix moldings

Specially formulated for low-cost pre-mix molding that permits rapid molding of parts with varying thicknesses, intricate contours and molded-in inserts.

Typical applications: Automotive heater housings, door liners and window frames, and ducts.

Adhesives

A *versatile* line including urea powder glue, urea liquid glue and hardeners for all types of gluing including hot and cold pressing, high frequency operations, veneer splicing, edge banding and lumber core gluing. Individual PLASKON Adhesives provide special properties such as ease of application and bonds that have a high degree of moisture resistance, and are non-staining and durable.

Typical applications: Hardwood plywoods, furniture, pianos, radio and TV cabinets, boats.

Phenolic laminating varnishes

Used in core stock for decorative laminates and in the preparation of industrial and general purpose laminates. Exceptional durability.

Typical applications: Kitchen and bathroom counter tops, furniture tops, bushings, electrical insulation, mechanical parts.

Urea resins

PLASKON Urea Resins for paper-treating provide great wet strength and improved folding endurance and dry strength.

Typical applications: All type paper products.

Polyester resins for polyurethane foams

Both rigid and flexible foams can be produced by using PLASKON Polyester Resins in conjunction with diisocyanates such as National Aniline Division's "Nacconate" diisocyanates. Foams are extremely strong and durable, rot-proof, non-toxic, odorless. They can be foamed in place for sandwich construction or in inexpensive molds on a batch basis or on a continuous machine for large sections.

Typical applications: Marine flotation chambers, refrigerator insulation, shoe innersoles, furniture padding and mattresses, sound and thermal insulation, rug underlays.

Foundry resins

PLASKON Foundry Resins include phenolic resins which produce highly permeable shell molds with excellent dimensional stability and smooth surfaces and result in precision castings. Urea, phenolic and alkyd resin types are used in both ferrous and non-ferrous metal castings for binding quick-baking, high-density cores.

Typical applications: Aluminum and magnesium sand castings, ferrous castings.

FOR MORE INFORMATION on the PLASKON Products mentioned here — or others — write to:

BARRETT DIVISION
Allied Chemical & Dye Corporation
40 Rector Street,
New York 6, N. Y.

Allied Chemical

Barrett PLASKON

When your engineers say,

"Open mesh fibreglass will do the job best, but who's going to handle the slippery stuff?"

Use SANDMAN'S multi-million yard impregnating experience for resin-ready fibreglass with

- **vinyls**
- **polyesters**
- **epoxies**
- **phenolics**

For results, phone, write or visit.

Eli Sandman Co.
280 GREENWOOD STREET
WORCESTER, MASS.
P. O. BOX 801
Telephone PLeasant 7-7781

Coast to coast service!

Melamine POLY-PREG: Melamine impregnated papers for decorative laminates; melamine glass cloth and mat for electrical sheets, rods and tubes.

Silicone POLY-PREG: Silicone impregnated glass cloth for low and high pressure laminates for use in the electrical and aircraft industries.

Epoxy POLY-PREG: A wide range of epoxy impregnated glass cloth and glass mat for the electrical and aircraft industries.

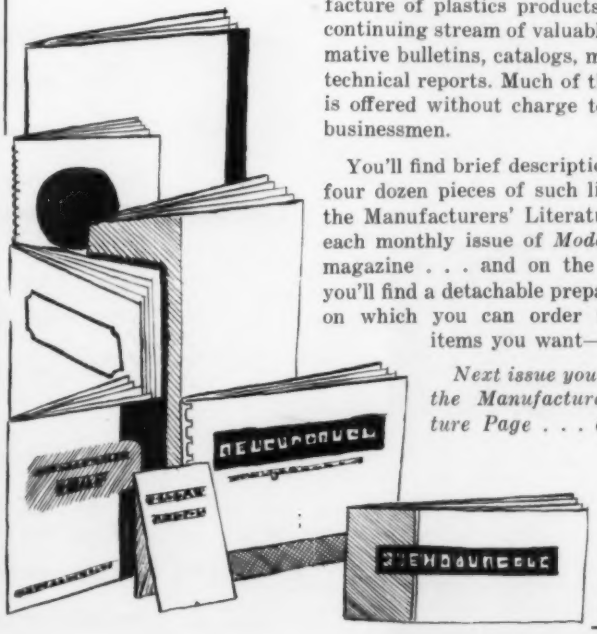
Polyester POLY-PREG: Polyester impregnated glass cloth and mat for aircraft and other industries.

Phenolic POLY-PREG: High temperature phenolic resin impregnated glass cloth and glass mat.



U. S. Polymeric Chemicals, Inc.
Stamford, Conn. • Santa Ana, Cal.

Yours for the asking!



The companies that supply the equipment, resins, chemicals, molding compounds and services used in the manufacture of plastics products turn out a continuing stream of valuable and informative bulletins, catalogs, manuals, and technical reports. Much of this material is offered without charge to interested businessmen.

You'll find brief descriptions of about four dozen pieces of such literature on the Manufacturers' Literature Page of each monthly issue of *Modern Plastics* magazine . . . and on the same page you'll find a detachable prepaid postcard on which you can order the specific items you want—*free.*

Next issue you get, turn to the Manufacturers' Literature Page . . . and use it!

Technical Data

Statistics of the Industry 555

Foamed Plastics Chart 556

Films Chart 559

Adhesives Chart 564

Coatings Chart 572

Fibers Chart 580

Laminates Chart 586

Low-Pressure Laminating Resins Chart 590

Plasticizers Chart 598

Bibliography of Books and Magazines 615

TABLE I: Synthetic Plastics and Resin Production, Dry Basis[a] (U. S. Tariff Commission)

Material	1955	1956
	1000 lb.	1000 lb.
CELLULOSE PLASTICS:		
Cellulose acetate and mixed ester, total	134,018	136,067
Sheets, under 0.003 gage	18,801	19,384
Sheets, 0.003 gage and over	15,855	16,656
All other sheets, rods, and tubes	7,646	7,282
Molding and extrusion materials	91,716	92,745
Nitrocellulose sheets, rods, and tubes	4,869	5,254
Other cellulose plastics	5,869	5,651
Total	144,756	146,972
PHENOLIC AND OTHER TAR ACID RESINS:		
Molding materials	220,276	214,729
Bonding and adhesive resins for:		
Laminating (except plywood)	82,215	62,832
Coated and bonded abrasives	15,763	15,644
Friction materials (brake linings, clutch facings, etc.)	25,502	b
Thermal insulation (rockwool, fibrous glass)	52,980	56,151
Plywood	44,533	44,187
All other bonding and adhesive uses	27,929	49,789
Protective coating resins, unmodified and modified, except by rosin	28,501	29,503
Resins for all other uses	37,778	39,455
Total	535,477	512,290
UREA AND MELAMINE RESINS:		
Textile-treating and textile-coating resins	47,883	40,784
Paper-treating and paper-coating resins	23,378	24,775
Bonding and adhesive resins for:		
Plywood	99,508	102,081
All other bonding and adhesive uses, including laminating	28,491	25,205
Protective coating resins, straight and modified	38,905	37,250
Resins for all other uses, including molding	90,215	87,167
Total	328,380	317,262
POLYESTER RESINS	61,544	72,588
STYRENE RESINS:		
Molding materials	423,208	433,037
Protective coating resins, straight and modified[c]	103,128	91,135
Resins for all other uses	92,864	104,416
Total	619,200	628,588
POLYETHYLENE	402,279	556,919

Material	1955	1956
	1000 lb.	1000 lb.
VINYL AND VINYL COPOLYMER RESINS[d] (resin content):		
Polyvinyl chloride and copolymer resins (50% or more PVC) for:		
Film (under 0.010 gage)	83,043	78,064
Sheeting (0.010 gage and over)	50,758	52,505
Molding and extrusion	183,131	203,812
Textile- and paper-treating and coating	63,780	62,931
Flooring	55,810	65,500
Protective coatings	26,315	28,522
All other uses	57,509	74,621
All other vinyl resins for:		
Adhesives	35,634	36,563
All other uses	108,503	115,075
Total	703,260	752,410
ALKYD RESINS:		
For protective coatings:		
Phthalic anhydride types:		
Unmodified	325,516	270,375
Modified	129,031	70,977
Polybasic acid types:		
Unmodified	25,597	3,931
Modified	11,469	11,710
For all other uses	6,164	16,049
Total	497,777	373,042
ROSIN MODIFICATIONS:		
Rosin esters for protective coatings:		
Unmodified (ester gums)	40,510	29,562
Modified (hard resins)	63,378	59,299
All other modifications for protective coatings and other uses	30,531	41,331
Total	134,419	130,192
COUMARONE-INDENE AND PETROLEUM POLYMER RESINS	292,574	245,586
MISCELLANEOUS SYNTHETIC PLASTICS AND RESINS:[e]		
Molding materials	51,629	43,542
Protective coating resins	22,691	11,448
Resins for all other uses	89,017	117,894
Total	163,337	172,884
GRAND TOTAL	3,883,003	3,908,734

[a] "Dry basis" is defined as the total weight of the material, *including* resin, plasticizers, fillers, extenders, colors, and stabilizers, and *excluding* the weight of water, solvents, and other liquid diluents.

[b] Included with "All other bonding and adhesive uses."

[c] Includes data for styrene-alkyd polyester resins.

[d] Statistics by use are based on sales; total is based on production.

[e] Includes data for acrylic, epichlorohydrin, polyamide (nylon), polyethylene, silicone, and other synthetic plastics and resin materials.

Foamed Plastics Chart

TYPE OF MATERIAL	URETHANE (POLYURETHANE; ISOCYANATE)								
	Open cell; soft, elastic	*Open cell; foam-in-place (flexible)*	*Open and closed cell; rigid*			*Open and closed cell; rigid; foamed in place*			
Forms available	Slab, sheets, blocks, custom shapes	2 and 3 package system for mixing on job	Custom made shapes			2 and 3 package system for mixing on job			
Standard sizes	Max. width: 80"; max. length: 120 ft.; thickness: 1/16-8"	–	–			–			
Density, lb./cu. ft.	1.5-4	2-20	1.5-3	4-8	9-12	13-18	19-25	26-40	41-70
Thermal conductivity, B.t.u./sq. ft./hr./°F./in.	0.25 at 4 lb./cu. ft.	0.25 at 4 lb./cu. ft.	–	0.21 at 4 lb./cu. ft.	–	–	–	–	–
Tensile strength, p.s.i.	18-50	13-150	8-50	75-225	250-325	375-500	525-800	–	–
Compressive strength, p.s.i.	0.3-1.0 (at 25%)	0.5-1.5 (at 25%)	7-30	50-225	250-400	425-800	900-1200+	–	–
Impact strength, ft.-lb./in.	–	–	–	–	–	0.32	–	–	–
Burning rate	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing	Self-extinguishing
Max. service temp., °F.	Dry 260-275 Wet 212	260-275 212	Continuous 250	Continuous 250	Continuous 250	Continuous 250	Continuous 250	Continuous 300	Continuous 300
Elongation, %	150-500	200-500	–	–	–	–	–	–	–
Coefficient of linear expansion, in./in./°F.	–	–	1.4×10^{5}	2.6×10^{5}	3.5×10^{5}	5.0×10^{5}	–	–	–
Water absorption, %	–	–	–	1.8	0.8	0.4	0.2	–	–
Dielectric constant	1.1	1.1	1.05	1.10	1.2	1.3	1.4	1.5	–
Loss tangent	0.5×10^{-3}	0.5×10^{-3}	0	0	0.5×10^{-3}	2.0×10^{-3}	3.0×10^{-3}	4.0×10^{-3}	–
Trade designations of this type of foam and foaming compounds	OPEN AND CLOSED CELL FOAM: Airborne (63), Airfoam SL (32), Allfoam (1), Burkart (8), Curifoam (13), Cush-N-Foam Polyester (36), Eccofoam S (22), Foamex E (24), Insulfoam (55), Isonire (20), Nopcofoam (48), Poly-Koolfoam (14), Polyfoam (29), Polylite (52), Sheller-Tex (59), Stafoam (2), Unifoam (9), Vibrafoam (64), Vinylfoam (21)					FOAMED IN PLACE: Cyofoam (4), Eccofoam FP (22), Fomrez (67), Loven (41), Mondur (45), Nopco Lockfoam (48), Poly-Koolfoam (14), Polylite (52), Polyrubber (2), Reynofoam (53), Scotchfoam (44), Selectrofoam (50), Stafoam, Lockfoam (2), Urefoam (4), Vibrathane (47)				
Manufacturers of this type of foam and foaming compounds (see list on p. 558 for key to numbers)	1, 2, 3, 7, 8, 9, 13, 14, 18, 19, 20, 21, 22, 23, 24, 29, 30, 32, 34, 36, 42, 48, 49, 52, 55, 59, 63, 64					4, 14, 22, 38, 41, 44, 45, 47, 48, 49, 50, 52, 53, 67			

TYPE OF MATERIAL	POLYVINYL CHLORIDE FOAMS					
	OPEN CELL			CLOSED CELL		
Forms available	Flat stock in sheets and rolls Cored cushions and other molded shapes	**Resistance ratings**		Forms available	Sheets and molded shapes	**Resistance ratings**
		Strong acids	E			Strong acids E
		Strong alkalies	E			Strong alkalies E
Standard sizes	1/16" to 5" thick; 24" to 54" wide	Grease and oils	G	Standard sizes	36" × 44", 1/16" to 2" thick	Grease and oils G
		Organic solvents	P to E			Organic solvents P to E
Density, lb./cu. ft.	4 and up	Water	E	Density, lb./cu. ft.	4 to 25	Water E
Heat sealability	Excellent	High relative humidity	E	Heat sealability	–	High relative humidity E
Tensile strength, p.s.i.	10 to 200	Sunlight	G	Tensile strength, p.s.i.	–	Sunlight G
Elongation, %	75 to 300	Resistance to heat, °F.	150 to 225*	Elongation, %	–	Resistance to heat, °F. 150 to 225*
Flammability	Self-extinguishing			Flammability	Self-extinguishing	
Indentation load deflection* (lb./50 sq. in. at 25% def.)	3 to 500	Resistance to cold, °F.	Stiffens at +20 to −40*	Indentation load deflection* (lb./50 sq. in. at 25% def.)	–	Resistance to cold, °F. Stiffens at +20 to −40*
Air oven aging, 22 hr. at 212°F.* (change from orig. ind. load def.), %	±20	Trade designations of this type of foam and foaming compounds	Aer-O-Buoy (56), Crestfoam (12), Fashon Foam PV (28), U.S. (64), Vin-So-Lite (26), Vinylaire (20), Vinacel (32), Wilflex (25)	Air oven aging, 22 hr. at 212°F.* (change from orig. ind. load def.), %	–	Trade designations of this type of foam and foaming compounds Aer-O-Buoy (56), Crestfoam (12), Ensolite (64), Gaifoam (33), Vin-So-Lite (26), Wilflex (25)
Compression set, 22 hr. at 158°F.* (max. based on original height), %	15			Compression set, 22 hr. at 158°F.* (max. based on original height), %	–	
Dynamic flexing—250,000 cycles* (max. set based on original height), %	10	Manufacturers of this type of foam and foaming compounds (see list on p. 558 for key to numbers)	7, 12, 20, 25, 26, 28, 29, 31, 32, 33, 35, 42, 46, 56, 64	Dynamic flexing—250,000 cycles* (max. set based on original height), %	–	Manufacturers of this type of foam and foaming compounds (see list on page 558 for key to numbers) 12, 25, 26, 33, 56, 64
Water absorption, %	–			Water absorption, %	5 (max.)	

*SPI Tentative Specifications and Methods of Test for Vinyl Foams.

*These compositions are the thermoplastic materials that gradually become softer as the temperature increases. The maximum and minimum service temperature will depend on formula of material, design of part, and service conditions.

TYPE OF MATERIAL	CELLULOSE ACETATE	PHENOLIC			UREA-FORMALDEHYDE	POLYSTYRENE					
Forms available	Boards and rods (rigid closed cell foam)	Liquid resin for foaming in place			Block and shred	Sheets or shapes molded from expandable beads			Homogeneous boards, planks and logs		
Standard sizes	Boards: 1" × 4"; ¾" × 6"; 1½" × 8"; 1½" × 3½". Rods: 1-3/8"; 2"; 2¼"; any length	–			Block: 20½" × 10½" by 4½"	–			Boards 10", 12" and 16" widths 1"–5" thickness 3' and 9' lengths Planks 5" × 15" × 9' 7" × 20" × 9' Logs 25" × 33" × 6' or 9'		
Density, lb./cu. ft.	6–8	1/3–1½	2–5	7–10	0.8–1.2	2.0	6.0	10.0	1.8	3.0	4.5
Thermal conductivity, B.t.u./sq. ft./hr./°F./in.	0.31	0.24–0.28			0.18–0.21	0.22	0.24	0.25	0.25 at 40°F. mean temperature		
Tensile strength, p.s.i.	190	–	4–35	35–75	Poor	55	90	130	55	105	180
Compressive strength, p.s.i.	150	0.8–5	9–31	45–130	200	20	100	240	16–32	50–80	120–140
Impact strength, ft.-lb./in.	0.12	–	–	–	Poor	0.17	0.3	0.42	–	–	–
Burning rate, in./min.	4.5	Self-extinguishing			–	–			Styrofoam 33: self-extinguishing Styrofoam 22: non-self-extinguishing		
Maximum service temperature, °F.	350	Continuous: 300			200	185			155–175		
Coefficient of linear expansion, 10^{-5} in./in./°F.	–	–	–	–	–	3–4			3–4		
Moisture absorption, % by wt.	–	–	100% R.H. = 13–51 50% R.H. = 1–4	100% R.H. = 10–15 50% R.H. = 1–5	–	Nil			Nil		
Water vapor transmission, g./hr./sq. ft./in./cm. Hg	–	–	–	–	–	2.0			1.5–3		
Dielectric constant	–	–	–	1.19–1.20	–	–			<1.05 at 10^3–10^8 cy./sec.		
Dissipation factor	–	–	–	0.028–0.031	–	–			<0.0002 at 10^3–10^8 cy./sec.		
Trade designations of this type of foam and foaming compounds	CCA (61), Strux (61)	Corfoam (54), Cosmalite (11), Eccofoam GL (22), GE (27), Kaston (51), Lebec (40), Marblette (43)			Colfoam (11)	Dow Q-865.2 (16), Dylite (39), Styrocell (62)			Eccofoam PS (22), Spherofoam (58), Styrocell (62), Styrofoam (16)		
Manufacturers of this type of foam and foaming compounds (see list on page 558 for key to numbers)	61	11, 22, 27, 40, 43, 51, 54, 66			11	16, 39, 62			16, 22, 58, 62		

TYPE OF MATERIAL	POLYVINYL CHLORIDE *Plastisol (containing blowing agent)*	SILICONE			RUBBERS			
					NATURAL RUBBER	NEOPRENE	BUTADIENE-STYRENE (GR-S)	BUTADIENE-ACRYLONITRILE
Forms available	Liquid or paste	Powder			Sheets	Sheets	Boards	Sheets
Standard sizes	Foamed in place 3-30' at 310–350°F. closed or open cell	Foamed in place at 320°F. Cell size less than 0.08 in.			40" × 120"; 1/8" to 1" thick	36" × 36" and 40" × 120"; 1/8" to 1" thick	36" × 36"; 1/2" to 2" thick	36" × 36"; 1/8" to 1" thick
Density, lb./cu. ft.	12–26	12	14	16	10–20	10–30	4.5	10–25
Thermal conductivity, B.t.u./sq. ft./hr./°F./in.	0.36	0.3	0.3	0.3	0.25–0.30	0.25–0.35	0.21	0.25–0.30
Tensile strength, p.s.i.	250–1200	–	–	–	15–30	20–100	80	40
Compressive strength, p.s.i.	–	100	200	325	–	–	40 and up	–
Impact strength, ft.-lb./in.		–	–	–	–	–	4–11	–
Burning rate, in./min.	Self-extinguishing	Nonflammable			–	–	–	–
Maximum service temperature, °F.	200	700			160	180	160	210
Trade designations of this type of foam and foaming compounds	Chem-o-sol (10), Dennis (15), Foamosol (65), Reynofoam (53), Stanley (60), Sterilkote (6), Vynafoam (37), Wilflex (25)	Dow Corning (17)			Airfoam (32), Fashon Foam (29), Foamex (24), Rubatex (33)	Foamex (24), Rubatex (33)	Airfoam (32), Foamex (24), Rubatex (33)	Rubatex (33)
Manufacturers of this type of foam and foaming compounds (see list on p. 558 for key to numbers)	6, 10, 15, 25, 37, 46, 53, 57, 60, 65	17			7, 18, 24, 29, 32, 33	7, 24, 33	7, 24, 32, 33	7, 33

LIST OF MANUFACTURERS OF FOAMED PLASTICS

1. American Collo Corp., 525-535 Oritan Ave., Ridgefield, N. J.
2. American Latex Products, Inc., 3341 W. El Segundo Blvd., Hawthorne, Calif.
3. American Rubber Products Corp., La Porte, Ind.
4. Atlas Mineral Products Co., Mertztown, Pa.
5. Balsa Ecuador Lumber Corp., 500 Fifth Ave., New York 36, N. Y.
6. Bradley and Vrooman Co., 2629 S. Dearborn St., Chicago 16, Ill.
7. Brown Rubber Co., Inc., Lafayette, Ind.
8. Burkart Manufacturing Co., F., Div. of Textron Inc., 4900 N. Second St., St. Louis 7, Mo.
9. Burnett and Co., Inc., W. T., Baltimore, Md.
10. Chemical Products Corp., King Philip Rd., E. Providence 14, R. I.
11. Colton Chemical Co., 1747 Chester Ave., Cleveland 14, Ohio
12. Crest Chemical Industries Corp., 72 Delavan St., Brooklyn 31, N. Y.
13. Curtiss-Wright Corp., Carlstadt, N. J.
14. Dayton Rubber Co., Dayton, Ohio
15. Dennis Chemical Co., 2701 Papin St., St. Louis 3, Mo.
16. Dow Chemical Co., The, Midland, Mich.
17. Dow Corning Corp., Midland, Mich.
18. Dryden Rubber Div., Sheller Manufacturing Corp., 1014 S. Kildare Ave., Chicago 24, Ill.
19. Dunlop Tire and Rubber Co., Buffalo, N. Y.
20. Dura-Flex Co., 2043 Colorado Ave., Santa Monica, Calif.
21. Elastomer Chemical Corp., 212 Wright St., Newark 5, N. J.
22. Emerson and Cuming, Inc., 869 Washington St., Canton, Mass.
23. Federal Industries, Div. of Textron Inc., Belleville 9, N. J.
24. Firestone Industrial Products Co., Div. of the Firestone Tire and Rubber Co., Fall River, Mass.
25. Flexible Products Co., P. O. Box 306, Marietta, Ga.
26. Foam King, Inc., 1816 Boston Rd., Bronx 60, N. Y.
27. General Electric Co., Pittsfield, Mass.
28. General Tire and Rubber Co., Bolta Products Div., Lawrence, Mass.
29. General Tire and Rubber Co., Industrial Products Div., Marion, Ind.
30. B. F. Goodrich Co., Akron 8, Ohio
31. B. F. Goodrich Sponge Products, Shelton, Conn.
32. Goodyear Tire and Rubber Co., 1210 Massillon Rd., Akron 15, Ohio
33. Great American Industries, Inc., Rubatex Div., Bedford, Va.
34. Hewitt-Robins, Inc., Buffalo, N. Y.
35. Hood Sponge Rubber Co., 340 W. Huron St., Chicago 10, Ill.
36. Hudson Foam Products, Saw Mill River Rd. & Lake Ave., Yonkers, N. Y.
37. Interchemical Corp., Finishes Div., P. O. Box 659, Newark 1, N. J.
38. Isocyanate Products, Inc., P. O. Box 1681, Wilmington, Del.
39. Koppers Co., Inc., Chemical Division, Pittsburgh 19, Pa.
40. Lebec Chemical Corp., 14066 S. Garfield Ave., Paramount, Calif.
41. Loven Chemical of Calif., Newhall, Calif.
42. Magic Chemical Co., 100 Crescent St., Brockton 2, Mass.
43. Marblette Corp., 37-21 30th St., Long Island City 1, N. Y.
44. Minnesota Mining and Mfg. Co., 411 Piquette Ave., Detroit 2, Mich.
45. Mobay Chemical Co., 1700 S. Second St., St. Louis 4, Mo.
46. Mono-Sol Corp., 407 County Line Road, Gary, Ind.
47. Naugatuck Chemical, Div. of U. S. Rubber Co., Naugatuck, Conn.
48. Nopco Chemical Co., Plastics Div., 175 Schuyler Ave., N. Arlington, N. J.
49. Pelron Corp., 7847 W. 47th St., Lyons, Ill.
50. Pittsburgh Plate Glass Co., Paint Div., 1 Gateway Center, Pittsburgh 22, Pa.
51. Poly Resins, 11661 Wicks St., Sun Valley, Calif.
52. Reichhold Chemicals, Inc., RCI Building, White Plains, N. Y.
53. Reynolds Chemical Products Co., 1200 N. Main St., Ann Arbor, Mich.
54. Rezolin, Inc., 5736 W. 96th St., Los Angeles 45, Calif.
55. Robinson Foams Ltd., 183 George St., Toronto, Canada
56. Robinson Moulded Products Ltd., 183 George St., Toronto, Ontario, Can.
57. Rubber Corp. of America, New South Rd., Hicksville, N. Y.
58. Schwab Plastics Corp., 730 S. Dix, Detroit 17, Mich.
59. Sheller Manufacturing Corp., Portland, Ind.
60. Stanley Chemical Co., E. Berlin, Conn.
61. Strux Corp., 37 W. John St., Hicksville, N. Y.
62. Styrene Products Ltd., 96 Piccadilly, London, W. 1, England
63. Trostel and Sons Co., Inc., Albert, Milwaukee, Wis.
64. U. S. Rubber Co., Mishawaka, Ind.
65. Watson-Standard Co., 225 Galveston Ave., Pittsburgh 30, Pa.
66. Westlake Plastics Co., Lenni Mills, Pa.
67. Witco Chemical Co., 122 E. 42nd St., New York 17, N. Y.

Films Chart (up to 10 mils thick)

TYPE OF PLASTIC BASE	POLYVINYL CHLORIDE		VINYL CHLORIDE-ACETATE COPOLYMERS		VINYLIDENE CHLORIDE-VINYL CHLORIDE COPOLYMER
	Rigid	*Nonrigid*	*Rigid*	*Nonrigid*	
1. Method of processing	Calendering, casting, extrusion	Calendering, casting, extrusion	Calendering, extrusion, casting		Calendering, casting, extrusion
2. Forms available	Sheets, rolls, tapes	Sheets, rolls, tapes	Sheets, rolls (nonrigid also in tapes, tubes)		Rolls
3. Thickness range, in.	0.001-0.010	0.001-0.010	0.001-0.010	0.001-0.010	0.0005-0.010
4. Maximum width, in.	54-84	54-84	54	84	54
5. Area factor[a]	20,000-23,000	20,000-23,000	21,000	21,000	16,000-23,000
6. Specific gravity	1.35-1.45	1.24-1.45	1.30-1.39	1.20-1.35	1.20-1.68
7. Tensile strength,[b] p.s.i.	7,000-10,000	1,400-5,600	5,500-8,000	2,000-4,500	1,800-15,000
8. Elongation,[b] percent	25	150-500	2-10	150-500	20-140
9. Bursting strength,[c] 1 mil thickness, Mullen points	30-40	20	–	20	35
10. Tearing strength,[d] gm.	10-700	60-1,400	10-30	30-1,400	10-> 100
11. Tearing strength,[e] lb./in.	110-490	110-490	–	–	80-465
12. Folding endurance[f]	–	–	–	–	>500,000
13. Water absorption,[g] 24 hr., percent	Negligible	Negligible	Negligible		Negligible
14. Water vapor permeability[h]	0.35-2.0	0.35-2.0	–	0.23	0.01-0.03
15. Permeability to gases, 10^{-6} g./24 hr./m.^{2}/mm. thick./cm. Hg at 21°C., 0% R.H.	CO_2 970 O_2 150 (50% R.H.)	CO_2 970 O_2 150 (50% R.H.)	–	–	CO_2 12 O_2 2.4 (50% R.H.)
Resistance rating[i]					
16. Strong acids	E	E	E	E	E
17. Strong alkalies	E	E	E	E	E
18. Grease and oils	G	G	E	M to E	G
19. Organic solvents	G	G	P to E	P to E	E
20. Water	E	E	E	E	E
21. High relative humidity	E	E	E	E	E
22. Sunlight	G	G	G	G	G
23. Resistance to heat,[p] °F.	150-200	150-200	Fair	150-200	150-200 (dry); 300 (wet)
24. Resistance to cold,[p] °F.	−50	−50	Good	Good	−25 to −50
25. Change in linear dimensions at 100°C. for 30 min.,[q] percent	+4.2 to −9.5	+4.2 to −9.5	–	–	–
26. Flammability	Slow to self-extinguishing	Slow to self-extinguishing	Slow burning to self-extinguishing		Self-extinguishing
27. Burning rate,[r] in./sec.	0.2-1.7	0.2-1.7	–	–	–
28. Trade designations of films (see list of manufacturers on page 563 for key to numbers in parentheses)	*Rigid* Arnar (62) Bakelite (7) Col-O-Vin (17) Joda PVC (20) Reet (62) Resproid (60) Seilon (66) Soplasco (67) Tolon (68) Velon (29) Wopavin (74) *Nonrigid* Arnar (62) Bakelite (7) Boltaflex (9) Clopane (16) Col-O-Vin (17) Coveray (16) Dorn (36) Fabray (16) Fabtex (16) Fashon (32) Ger-Pak (33) Hyben (6) Koroseal (34) Mono-Sol (43) Naugahyde (70) Nixon Vine-L (46) Pantex (48) Prestoflex (57) Randfilm (58) Reet (62) Resiloid (26) Resinite (10) Resproid (60) Reynolon (61) Rucoam (64) Soplasco (67) Spunglow (62) Syntilon (50) Tolon (68) Ultron (44) Velon (29) Vinylfilm (35) Visten (71) Vitafilm (35) Vitalon (35) Vylene (26) Wataseal (38) Wopavin (74)	Arnar (62) Bakelite (7) Col-O-Vin (17) Joda PVC (20) Reet (62) Resproid (60) Seilon (66) Soplasco (67) Tolon (68) Velon (29) Wopavin (74)	Arnar (62) Bakelite (7) Col-O-Vin (17) Dorn (36) Fabray (16) Fabtex (16) Krene (7) Nixon Vine-L (46) Pantex (48) Randfilm (58) Reet (62) Resinite (10) Resproid (60) Revelry (68) Reynolon (61) Soplasco (67) Syntilon (50) Tolon (68) Vinylite (7) Wataseal (38) Wopavin (74)	Pantex (48) Randfilm (58) Saran (22)
29. Manufacturers or processors of films (numbers refer to list on page 563)	7,17,20,29,36,48,60,62,63,64,66,67,68,72,74	2,6,7,9,10,16,17,23,24,26,29,32,33,34,35,36,38,43,44,46,48,50,57,58,60,61,62,64,65,67,68,71,74	7,17,20,29,36,48,60,62,63,64,66,67,68,72,74	7,16,17,36,38,46,48,50,58,60,61,62,63,64,65,67,68,70,72,74	22,48,58,64,71

TYPE OF PLASTIC BASE	REGENERATED CELLULOSE (CELLOPHANE)	CELLULOSE ACETATE	CELLULOSE TRIACETATE	CELLULOSE ACETATE BUTYRATE	CELLULOSE NITRATE	ETHYL CELLULOSE
1. Method of processing	Extrusion into bath	Casting, extrusion	Casting	Casting, extrusion	Block, casting, extrusion	Casting
2. Forms available	Sheets, rolls, ribbons	Sheets, rolls, tapes	Sheets, rolls	Sheets, rolls	Sheets, rolls	Sheets, rolls, tapes
3. Thickness range, in.	0.0009-0.0017	0.0005-0.010	0.0008-0.010	0.0011-0.010	0.0005-0.010	0.003-0.010
4. Maximum width, in.	60	40-60	40	40	50	28-29
5. Area factor[a]	17,900-19,800	21,000-22,000	21,200-21,400	23,600	20,000	24,000
6. Specific gravity	1.40-1.50	1.28-1.43	1.29-1.31	1.19-1.22	1.42-1.46	1.14-1.16
7. Tensile strength,[b] p.s.i.	4,400-18,600	5,400-13,900	9,000-16,000	4,100-9,700	10,000-11,000	6,800-10,600
8. Elongation,[b] percent	15-45	25-45	10-40	40-100	30-40	30-40
9. Bursting strength,[c] 1 mil thickness, Mullen points	55-65	30-70	50-350	50-220	40-50	50-85
10. Tearing strength,[d] gm.	2-10	2-25	4-6	3-5	–	7-36
11. Tearing strength,[e] lb./in.	110-515	55-415	55-395	80-105	–	215-395
12. Folding endurance[f]	–	250-400	3,500-4,000°	1,200-1,500°	50-250	2,700
13. Water absorption,[g] 24 hr., percent	45-115	3.6-6.8	3.5-4.5	0.1-3.4	1.5-2.0	2.5-7.5
14. Water vapor permeability[h]	1.4-2.7(NMP) 0.008-0.03(MP)	1.4-8.8	4.8-6.0	4.5-6.5	–	4.8-14.2
15. Permeability to gases, 10^{-6} g./24 hr./m.^{2}/mm. thick./cm. Hg at 21°C., 0% R.H.	CO_2 3 O_2 <0.5 N_2 <0.5	CO_2 10,000 O_2 970 N_2 160	High	High	–	High
Resistance rating						
16. Strong acids	P	P	P	P	G	F
17. Strong alkalies	P	P	P	P	M	E
18. Grease and oils	E	G	G	F	M	G
19. Organic solvents	Moistureproof coating attacked	P[j]	P[j]	P[j]	P[j]	P
20. Water	M	G	G	G	G	E
21. High relative humidity	M	G	G	G	G	E
22. Sunlight	G	G	E	G	P	G
23. Resistance to heat,[p] °F.	300	150-220	300-400	120-180	140	200-250
24. Resistance to cold,[p] °F.	Good	–	–	–	–	−90
25. Change in linear dimensions at 100° C. for 30 min.,[q] percent	−0.7 to −4.2	+0.2 to −3.0	0 to −0.8	+0.1 to −3.0	–	0 to −0.7
26. Flammability	Slow burning	Slow to self-extinguishing	Slow burning	Slow burning	–	Slow burning
27. Burning rate,[r] in./sec.	0.7-2.3	0.3-2.2	0.2-0.4	1.0-2.4	–	0.3-0.6
28. Trade designations of films (see list of manufacturers on page 563 for key to numbers in parentheses)	Avisco cellophane (4) DuPont cellophane (23) Olin cellophane (47)	Cadco (11) Campco (12) Celanese (13) Inceloid A (3) Joda C/A (20) Kodapak I (25) Lumarith (13) Midlon (41) Nixon (46) Soplasco (67) Vuepak (44) Wopalon (74)	Kodapak IV (25)	Cadco (11) Campco (12) Genco CAB (31) Joda C/AB (20) Kodapak II (25) Midlon (41) Nixon CAB (46) Soplasco (67)	Inceloid N (3) Joda C/N (20) Nitron (44) Nixon C/N (46) Wopaloid (74)	Campco (12) Ethocel (22) Inceloid E (3) Joda E/C (20) Nixon E/C (46) Soplasco (67)
29. Manufacturers or processors of films (numbers refer to list on page 563)	4, 23, 47, 67	3, 11, 12, 13, 20, 23, 25, 31, 41, 44, 46, 52, 63, 65, 67, 72, 74	25, 67	11, 12, 20, 25, 31, 41, 46, 52, 65, 67	3, 20, 23, 44, 46, 67, 74	3, 12, 20, 22, 41, 46, 52, 67

	POLYVINYL ALCOHOL	POLYTETRA-FLUORO-ETHYLENE	POLYCHLORO-TRIFLUORO-ETHYLENE	POLYSTYRENE		ACRYLONITRILE-STYRENE COPOLYMER	POLYAMIDE (NYLON)
1.	Casting	Block, casting, extrusion	Casting, extrusion, molding	Casting, extrusion	Two-way stretch orientation	Two-way stretch orientation	Extrusion
2.	Rolls, sheets, tapes	Sheets, tapes, tubing	Tubing, rolls, sheets, tapes	Rolls, sheets	Rolls, sheets	Rolls	Rolls
3.	0.0005-0.010	Up to 0.010	0.002-0.010	0.0004 and up	0.001-0.010	0.001-0.010	0.001-0.010
4.	54	12	20	40	43	43	18
5.	21,600	12,800	12,000	26,100	26,100	25,400	24,000
6.	1.21-1.31	2.1-2.2	2.1-2.2	1.05-1.06	1.05-1.06	1.08-1.09	1.08-1.14
7.	4,500-9,500	1,500-3,500	6,300-6,600	7,100-12,100	7,100-12,100	10,000-15,000	9,000
8.	180-600	100-300	90-200	3-10	3-10	–	Orients
9.	–	–	42 (2 mil film)	–	–	–	–
10.	High	10-100	200-350	–	–	–	–
11.	785-890	–	–	270-495	270-495	–	–
12.	–	–	–	–	–	–	–
13.	80	0.00	0.00	Nil	0.04-0.06	–	1.0-1.5
14.	0.1	0.0	0.00	0.5-0.7	–	0.4-0.5	0.3-1.8
15.	CO_2 200 O_2 120 (50% R.H.)	–	–	CO_2 16,000 O_2 2,200	Air 105[u] CO_2 1080[u] H_2 2420[u] N_2 49.5[u] O_2 310[u]	CO_2 210[u] N_2 9[u] O_2 36[u]	CO_2 160 O_2 25 (50% R.H.)
16.	P	E	E	G	G	G	P
17.	P	E	E	E	E	E	E
18.	E	E	E	G	G	G	E
19.	E	E	E	E to P	E to P	E to P	E
20.	P	E	E	E	E	E	E to P
21.	P	E	E	E	E	E	E to P
22.	E	E	E	G	G	E	–
23.	–	500	300	175-200	175	185	180-380
24.	–	<−130	−80	–	–	–	−60
25.	−3.2	–	–	−4.6 to −37.4	–	–	–
26.	Slow burning	Nonflammable	Nonflammable	Slow burning	Slow burning	Slow burning	Self-extinguishing
27.	0.8-0.9	–	–	–	–	–	–
28.	Inceloid (3) Mono-Sol (43) Reynolon (61)	Scotch (42) Teflon (23)	Fluorothene (generic) (7) Triplax (52) Trithene (71)	Cadco (11) Campco (12) Joda P/S (20) Midlon (41) Soplasco (67) Styco (46)	Polyflex 100 (52) Styroflex (45)	Polyflex 200 (52) Styron 60 (22)	Cadco (11) Nylam (37) Plastex (49) Supronyl (55)
29.	3, 43, 61, 67	18, 30, 42, 55, 56, 67, 69	30, 52, 67, 71, 73	11, 12, 20, 22, 31, 41, 46, 52, 63, 65, 67, 72, 73	41, 45, 52, 67	22, 52	11, 37, 49, 55, 56, 67

TYPE OF PLASTIC BASE	POLYETHYLENE TEREPHTHALATE	POLYMETHYL METHACRYLATE	POLYETHYLENE	RUBBER HYDRO-CHLORIDE	VINYL-NITRILE RUBBER
1. Method of processing	Casting, extrusion	Extrusion, two-way stretch orientation	Calendering, extrusion	Casting	Casting, extrusion
2. Forms available	Sheets, rolls, tapes	Rolls, sheets	Rolls, sheets, tapes, tubes	Rolls, sheets, tapes	Rolls, sheets, tapes, tubing
3. Thickness range, in.	0.00025-0.0075	0.005-0.010	0.0005-0.010	0.0004-0.0025	0.001-0.003
4. Maximum width, in.	50-55	43	108	60	11.5-41.5
5. Area factor[a]	20,000	23,400	30,100	25,000	22,800-23,700
6. Specific gravity	1.38-1.39	1.18-1.19	0.91-0.92	1.11	1.18-1.21
7. Tensile strength,[b] p.s.i.	17,000-23,700	8,200-8,800	1,100-3,500	3,500-5,000	2,500-4,000
8. Elongation,[b] percent	35-110	4-12	200-800	200-800	250-500
9. Bursting strength,[c] 1 mil thickness, Mullen points	45-60	–	–	Stretches	–
10. Tearing strength,[d] gm.	10-27	–	60-200	60-1,600	200-960
11. Tearing strength,[e] lb./in.	650-1,740	340-380	65-575	–	–
12. Folding endurance[f]	20,000	–	–	250,000	Very high
13. Water absorption,[g] 24 hr., percent	<0.5	0.3-0.4	0-0.8	5	Negligible
14. Water vapor permeability[h]	0.05-0.15 (MP)	0.5	0.04-0.08	0.007-0.23[s]	–
15. Permeability to gases, 10^{-4} g./24 hr./m.^{2}/mm. thick./cm. Hg at 21°C., 0% R.H.	CO_2 <0.5 O_2 <0.5 N_2 <0.5	–	CO_2 12,000 O_2 1,900	CO_2 288-13,500[t] O_2 38-3,250[t]	Low
Resistance rating[j]					
16. Strong acids	G	G	E	G	G
17. Strong alkalies	G	G	E	G	G
18. Grease and oils	E	P	M to G	E	E
19. Organic solvents	E	–	G° (60°C.)	G[n]	G[m]
20. Water	E	G	E	E	E
21. High relative humidity	E	G	E	E	E
22. Sunlight	M	E	G	F	M
23. Resistance to heat,[p] °F.	300	155-190	200	180-205	200
24. Resistance to cold,[p] °F.	−80	Good	−70	−20	32
25. Change in linear dimensions at 100°C. for 30 min.,[q] percent	<0.5	–	+10.4 to −19.9	–	–
26. Flammability	Slow burning to self-extinguishing	Slow burning	Slow burning	Self-extinguishing	Slow burning
27. Burning rate,[r] in./sec.	–	0.1	–	–	–
28. Trade designations of films (see list of manufacturers on page 563 for key to numbers in parentheses)	Melinex (39) Mylar (23)	Methaflex (52)	Amar (62) BiSeal (8) Cadco (11) Campco (12) Cheslene TF (14) Clopay (16) Durethene (24) Extrudo-Film (28) Fairlon (15) Firestone (29) Ger-Pak (33) H & R (37) Jodapak (20) Katharon (62) Layflat (52) Midlon (41) Olin PE (47) Plicose (53) Polyfilm (27) Polyken (40) Polytex (48) Polython (54) Polytreat (27) Prestolene (57) Reet (62) Relthene (59) Resinol (1) Reynolon (61) Soplasco (67) Spunglow (62) Visqueen (71)	Pliofilm (35)	Randfilm (58) Visten (71)
29. Manufacturers or processors of films (numbers refer to list on page 563)	23, 39, 67	52, 63, 67, 72	1, 5, 8, 11, 12, 14, 15, 16, 19, 20, 21, 23, 24, 27, 28, 29, 33, 37, 40, 41, 47, 48, 51, 52, 53, 54, 57, 59, 61, 62, 63, 65, 67, 70, 71, 72, 73	35, 67	36, 58, 61, 67, 71

LIST OF MANUFACTURERS AND PROCESSORS OF FILMS*

1. Allied Resinous Products, Inc., 525 W. Adams St., Conneaut, Ohio
2. American Lucoflex, Inc., 500 5th Ave., New York 36, N.Y.
3. American Products Mfg. Co., 8127 Oleander St., New Orleans 18, La. (0.5 to 3 mils)
4. American Viscose Corp., Film Div., 1617 Pennsylvania Blvd., Philadelphia 3, Pa.
5. Amos Packaging, Div. of Amos-Thompson Corp., Edinburg, Ind.
6. Associated Rubber and Plastic Corp., 2780 Park Ave., New York 51, N.Y.
7. Bakelite Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17, N.Y.
8. Bishop Manufacturing Corp., 10 Canfield Rd., Cedar Grove, N.J.
9. Bolta Products, Div. of The General Tire and Rubber Co., Lawrence, Mass.
10. Borden Co., The, Chemical Div., Resinite Dept., Santa Barbara, Calif.
11. Cadillac Plastic and Chemical Co., 15111 Second Ave., Detroit 3, Mich.
12. Campco Div., Chicago Molded Products Corp., 1020 N. Kolmar Ave., Chicago 51, Ill.
13. Celanese Corp. of America, 290 Ferry St., Newark 5, N.J.
14. Chester Packaging Products Corp., 684 Nepperhan Ave., Yonkers, N.Y.
15. Chippewa Plastics, Inc., Chippewa Falls, Wis.
16. Clopay Corp., Film Products Div., Clopay Sq., Cincinnati 14, Ohio
17. Columbus Coated Fabrics Corp., 7th and Grant Ave., Columbus 16, Ohio
18. Continental-Diamond Fibre Co., Newark, Del.
19. Contour Extrusion Co., 517 Fayette Ave., Mamaroneck, N.Y.
20. Davis Plastics Co., Joseph, Schuyler & Quincy Ave., Arlington, N. J.
21. Deerfield Plastics Co., Inc., 271 Main St., S. Deerfield, Mass.
22. Dow Chemical Co., The, Midland, Mich.
23. du Pont de Nemours and Co., Inc., E.I., Film Dept., Wilmington, Del.
24. Durethene-Koppers Co., Inc., 7001 W. 60th St., Chicago 38, Ill.; 5600 W. Arbor Vitae St., Los Angeles, Calif.
25. Eastman Kodak Co., Rochester 4, N.Y.
26. Elm Coated Fabrics Co., 261 5th Ave., New York 16, N.Y.
27. Extruders, Inc., 3232 West El Segundo Blvd., Hawthorne, Calif.
28. Extrudo-Film Corp., 36-35 36th Street, Long Island City 6, N.Y.
29. Firestone Plastics Co., Pottstown, Pa.
30. Garlock Packing Co., Palmyra, N.Y.
31. General Plastics Corp., 1400 N. Washington St., Marion, Ind.
32. General Tire & Rubber Co., Pennsylvania Div., Jeannette, Pa.
33. Gering Products Inc., N. 7th St. & Monroe Ave., Kenilworth, N.J.
34. Goodrich Co., The B. F., Akron 18, Ohio
35. Goodyear Tire & Rubber Co., Akron 16, Ohio
36. Gordon-Lacey Chemical Products Co., Inc., Maspeth, L.I., N.Y.
37. H & R Industries, 344 E. Walnut St., Nazareth, Pa.
38. Harte & Co., Inc., 16 E. 34th St., New York 16, N.Y.
39. Imperial Chemical Industries Ltd., Millbank, London, S.W. 1, England
40. Kendall Co., 309 W. Jackson Blvd., Chicago 6, Ill.
41. Midwest Plastic Products Co., 1801 Chicago Road, Chicago Heights, Ill.
42. Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn.
43. Mono-Sol Corp., 407 County Line Road, Gary, Ind.
44. Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.
45. Natvar Corp., 211 Randolph Ave., Woodbridge, N.J.
46. Nixon Nitration Works, Nixon, N.J.
47. Olin Film Div., Ecusta Paper Corp., subsidiary of Olin Mathieson Chemical Corp., 655 Madison Ave., New York 21, N.Y.
48. Pantasote Co., 415 Madison Ave., New York 17, N.Y.
49. Plastex Process Co., 230 W. Passaic St., Maywood, N.J.
50. Plastic Film Corp., 475 Fifth Ave., New York 17, N.Y.
51. Plastic Horizons Inc., 2 E. 5th St., Paterson 1, N.J.
52. Plax Corp., P.O. Box 1019, Hartford, Conn.
53. Plicose Mfg. Corp., 16 E. 34th St., New York 16, N.Y.
54. Poly Plastic Products, Inc., 2 4th Ave., Paterson 4, N.J.
55. Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa.
56. Polypenco, Inc., 2150 Fairmont Ave., Reading, Pa.
57. Presto Plastics Products Co., Inc., 11 E. 26th St., New York 10, N.Y.
58. Rand Rubber Co., Summer Ave. & Halsey St., Brooklyn 16, N.Y.
59. Reliance Plastic and Chemical Corp., 110 Kearney St., Paterson 2, N.J.
60. Respro, Div. of The General Tire and Rubber Co., 530 Wellington Ave., Cranston 10, R.I.
61. Reynolds Metals Co., Plastics Div., P.O. Box 128, Grottoes, Va.
62. Ross & Roberts Co., Div. of Pollak Industrial Corp., 1299 W. Broad St., Stratford, Conn.
63. Rotuba Extruders, Inc., 437 88th St., Brooklyn 9, N.Y.
64. Rubber Corp. of America, New South Road, Hicksville, L.I., N.Y.
65. Scranton Plastic Laminating Corp., 3218 Pittston Ave., Scranton, Pa.
66. Seiberling Rubber Co., Plastics Div., Newcomerstown, Ohio
67. Southern Plastics Co., 408 Pendleton St., Columbia, S.C.
68. Textileather Div., The General Tire and Rubber Co., 607 Madison Ave., Toledo 3, Ohio
69. United States Gasket Co., P.O. Box 93, Camden 1, N.J.
70. United States Rubber Co., 1230 Avenue of the Americas, New York 20, N.Y.
71. Visking Corp., Plastic Div., Terre Haute, Ind.
72. Waljohn Plastics, 437 88th St., Brooklyn 9, N.Y.
73. Westlake Plastics Co., Lenni Mills, Pa.
74. Worbla Ltd., Papiermuhle-Berne, Switzerland

*The values reported in this chart are only for films up to 0.01 in. in thickness. The information was obtained from various sources. Special grades of these materials may be obtained which excel in some particular property. Manufacturers should be consulted for additional or specific information or for new uses of their materials.

[a]Square in. per lb. of film in 1 mil (0.001 in.) thickness. Figures may vary with resin plasticizer ratio. [b]ASTM D882, procedure B [c]ASTM D774 [d]Elmendorf test. Figures represent pull required to continue tear of 1 mil thick film after starting. Force required to start tear is too high to measure on same equipment and therefore is not normally determined. [e]SPI-ASTM D1004, static-weighing method. [f]Using 1 mil thick film and the Schopper Bending Endurance Tester, unless otherwise noted. [g]ASTM D570 [h]ASTM D697; values are in grams/24 hr./m.^{2}/mm. thickness/cm. Hg at 25°C. [i]Code for rating: E = Excellent, G = Good, M = Moderate, F = Fair, P = Poor. [j]Except aliphatic and petroleum hydrocarbons. [k]Except H_2SO_4 and HNO_3. [l]Except NH_4OH. [m]Except ketones and esters. [n]Except chlorinated solvents, ketones, esters, and hot aromatic hydrocarbons. [o]Except hydrocarbons and chlorinated solvents. [p]These compositions are the thermoplastic materials that gradually become softer as the temperature increases. The maximum and minimum service temperature will depend on formula of material, design of part and service conditions such as amount of stressing, humidity, etc. Requirements for resistance to heat and cold should be considered as special problems. Where a range of values is given in the chart, the low value is the limiting temperature for continuous exposure and the high value for intermittent exposure. [q]ASTM D1204. [r]Paragraph 4.10 in Commercial Standard CS192-53. [s]Grams/24 hr./100 sq. in. at 100°F. and 90% relative humidity. [t]cc./24 hr./100 sq. in. at 25°C. and 0% relative humidity. [u]cc./24 hr./100 sq. in./mil thickness/cm. Hg at 25°C.

Adhesives Chart

TYPE OF PLASTIC BASE	BONDING CLASSIFICATION[a]	SOLVENTS[b]	RESISTANCE RATING[c]					EFFECTIVENESS[c] OF BOND WITH:							
			Water	*Solvents*	*Heat*	*Cold*	*Fungus*	*Wood*	*Metals*	*Rubber*	*Glass*	*Leather*	*Paper*	*Textiles*	*Ceramics*
1. Acrylate and methacrylate resins															
1a. Ethyl acrylate	SR	E, K	E	F	G	G	E	G	F	P	G	G	G	G	G
1b. *n*-Butyl methacrylate	SR	E, H, K	E	F	P	G	E	G	F	G	G	G	G	G	G
1c. Isobutyl methacrylate	SR	E, H, K	E	F	F	G	E	G	F	P	G	G	G	G	G
1d. Ethyl methacrylate	SR, F	Cl, E, H	G	F	P	G	E	M	F	M	G	G	E	G	M
1e. Methyl methacrylate	SR, F	Cl, E, H, K	G	P	M	G	E	P	P	M	P	G	E	E	F
2. Alkyd resins	SR, F	E, H, W	G	M	P	M	E	G	M	G	G	E	E	E	M
3. Animal glue	SR	W	P	E	M	G	F	E	P	P	M	E	E	E	P
4. Asphalt	H, W	H	G	P	P	G	E	M	G	G	G	M	G	G	F
5. Blood															
5a. Blood albumin	SR	W	P	G	F	F	F	F	P	P	P	G	G	G	P
	M	W	M	G	M	M	F	G	G	P	P	G	G	E	P
5b. Soluble dried blood	SR	W	P	G	F	F	F	M	P	P	P	G	G	G	P
	M	W	M	G	M	M	F	G	G	P	P	E	E	E	P
6. Casein	CR, SR	W	M	G	M	M	F	G	P	P	P	G	G	M	P
7. Cellulose derivatives															
7a. Cellulose acetate	SR, F	Cl, E, K	F	M	G	F	E	M	P	P	P	G	E	G	F
7b. Cellulose acetate butyrate	SR, F	A + H, Cl, E, H, K	F	F	F	F	E	M	F	F	F	G	E	E	F
7c. Cellulose nitrate	SR	E, K (+A, H)	F	F	M	F	E	G	F	P	M	E	E	E	M
7d. Ethyl cellulose	SR, F	A, E, H, K	M	P	F	E	E	F	M	M	P	M	E	G	P
7e. Hydroxyethyl cellulose	SR, F	W	P	E	G	G	M	–	–	F	–	G	E	E	G
7f. Methyl cellulose	SR	W	P	E	M	G	E	M	P	F	P	M	E	M	P
7g. Sodium carboxymethyl cellulose	SR	W	P	E	M	G	F	–	–	–	–	–	–	–	–
8. Coumarone-indene resins	SR, F	Cl, E, H, K, W	E	P	F	M	E	M	G	G	G	G	G	G	F
9. Epoxy resins	CR, H, M, R	None needed	E	E	E	E	E	E	E	G	E	E	E	E	E
10. Furan resins (furfuryl alcohol or furfural-ketone)	R	A, K, Cl	E	E	E	E	E	G	P	G	M	M	E	E	E
	H	A, K, Cl	E	E	E	M	E	E	P	G	M	G	M	E	E
	CR	A, K, Cl	E	E	E	M	E	E	F	P	G	M	P	P	E
11. Gum arabic	SR	W	P	M	F	F	P	F	P	P	P	M	E	M	P
12. Hydrocarbon resins from petroleum	SR, F	Cl, E, H, HA, W	E	P	F	M	E	M	G	G	G	G	G	G	F
13. Isobutylene resins (polyisobutylene)	SR	H, HA	E	P	F	G	E	P	P	P	P	G	G	G	P

[a]Code for bonding classification: SR = Solvent released (from solution or emulsion); F = Fused by heating; V = Vulcanized; R = Cured at room temperature (70–80°F.); M = Cured at moderate temperature (150–200°F.); H = Cured at elevated temperature (275–310°F.); CR = Chemically reacted.

TRADE DESIGNATIONS	MANUFACTURERS OR SUPPLIERS OF RESINS OR ADHESIVES *(See list on pp. 570–1 for key to numbers)*
1.	
1a. Acrigrip (4), CD Cement (40), Farrington (57), Lucite (52), Midland (88), Plastibond (69), Polybond (114), Upaco (136)	2, 4, 19, 40, 52, 57, 58, 69, 78, 85, 88, 107, 112, 114, 126, 129, 136, 145
1b. Acrigrip (4), Arcco (32), Bondmaster (123), CD Cement (40), Cordo-Bond (45), Dennis (48), Lucite (52), Midland (88), Placco (32), Polybond (114), Polyco (32), Reslac (32)	2, 4, 19, 32, 40, 45, 48, 52, 58, 76, 88, 107, 112, 114, 116, 123, 126, 145
1c. Acrigrip (4), Bondmaster (123), CD Cement (40), Lucite (52), Midland (88), Polybond (114), Upaco (136)	2, 4, 19, 40, 52, 58, 76, 88, 107, 112, 114, 116, 123, 126, 136, 145
1d. Acrigrip (4), CD Cement (40), Fuller (61), Midland (88), Polybond (114), Upaco (136)	2, 4, 19, 40, 58, 61, 76, 88, 107, 112, 114, 116, 121, 126, 136, 145
1e. Acrigrip (4), Acryloid (121), Arcco (32), Bedacryl (77), Bondmaster (123), Bostik (24), CD Cement (40), Farrington (57), Fuller (61), Inceloid (12), Lebec (82), Loxite (146), Lucite (52), Midland (88), Placco (32), Polybond (114), Polyco (32), Reslac (32), Rez-N-Bond (126), Upaco (136)	2, 4, 12, 19, 24, 32, 34, 40, 52, 57, 58, 61, 76, 77, 78, 82, 88, 107, 112, 114, 116, 121, 123, 126, 129, 136, 145, 146
2. Alkydol (7), Fuller (61), G-E Glyptal (64), Midland (88), Miracle (90), Ohio (102), Paralac (77), Rubbagrip (122), Upaco (136)	4, 7, 16, 19, 23, 34, 61, 64, 77, 88, 90, 102, 122, 136, 145
3. API (5), Fedroflex (58), Fuller (61), Hallmark (130), Hu-Flex (76), Impervo (95), Layton (103), Midland (88), Paisley (103), Polybond (114), Stixo (61), Upaco (136)	5, 15, 18, 58, 61, 74, 76, 88, 95, 103, 112, 114, 129, 130, 131, 136, 144
4. API (5), Arcco (32), Atlantic (21), Bondmaster (123), Cascola (32), Flintkote (59), Fuller (61), Indu-Sealz (97), Lebec (82), Loxite (146), Midland (88), Miracle (90), Ohio (102), Placco (32), Residex (103), Resinex (71), Reslac (32), Transphalt (104), 3 M (89)	4, 5, 12, 19, 21, 32, 59, 61, 71, 82, 88, 89, 90, 97, 102, 103, 104, 123, 146
5.	
5a. Hallmark (130)	18, 130, 132
5b. A-M (11), Hallmark (130)	11, 18, 130
6. A-M (11), API (5), Bindtite (74), Casco (32), Erie (71), Fedco (58), Fuller (61), Hu-Case (76), Impervo (95), Lauxein (92), Lebec (82), Lotol (97), Midland (88), Miracle (90), National Casein (96), Paisley (103), Perfection (105), Permaweld (112), Plyacien (118), Polybond (114), Upaco (136)	4, 5, 11, 15, 19, 32, 58, 60, 61, 71, 74, 82, 85, 88, 90, 92, 95, 96, 102, 103, 105, 112, 114, 118, 129, 131, 132, 136
7.	
7a. API (5), Arcco (32), Bondmaster (123), CD Cement (40), Farrington (57), Hercules CA (72), Midland (88), Miracle (90), Ohio (102), Placco (32), Plastibond (69), Plastigrip (4), Plastite (110), Polybond (114), Reslac (32), Resyn (95), Rez-N-Bond (126), Rubbagrip (122), Slomons (129), Tenite Acetate (54, 134), Upaco (136), Vinylgrip (4)	4, 5, 14, 23, 32, 40, 52, 54, 57, 69, 72, 88, 90, 92, 95, 102, 107, 110, 112, 114, 116, 117, 122, 123, 126, 129, 134, 136, 145
7b. CD Cement (40), Midland (88), Plastibond (69), Plastigrip (4), Rez-N-Bond (126), Tenite Butyrate (54, 134)	4, 32, 40, 54, 61, 69, 88, 107, 112, 116, 117, 126, 134, 136, 144, 145
7c. API (5), Arcco (32), Bond (30), Bondmaster (123), Bostik (24), CD Cement (40), Cello-weld (112), Cellument (103), Compo (44), Dennis (48), Duco (52), Farrington (57), Fuller (61), Herculoid (72), Inceloid (12), Loxite (146), Midland (88), Miracle (90), Ohio (102), Placco (32), Plastigrip (4), Plastite (110), Polybond (114), Reslac (32), Resyn (95), Upaco (136)	4, 5, 12, 14, 15, 24, 30, 32, 40, 44, 48, 52, 57, 61, 72, 76, 85, 88, 90, 92, 95, 102, 103, 107, 110, 112, 114, 116, 117, 123, 126, 129, 136, 145, 146
7d. API (5), CD Cement (40), Ethocel (50), Farrington (57), Fuller (61), Hercules EC (72), Inceloid (12), Midland (88), Plastibond (69), Plastigrip (4), Polybond (114), Resyn (95), Rez-N-Bond (126), Spotseal (103)	4, 5, 12, 14, 15, 32, 40, 50, 57, 61, 69, 72, 76, 88, 95, 103, 107, 112, 114, 116, 117, 126, 129, 131, 136, 144, 145
7e. Cellosize (35), Midland (88), Polybond (114)	35, 88, 107, 112, 114, 136, 145
7f. Bond (30), Midland (88), Paisley (103), Polybond (114)	4, 15, 30, 50, 67, 88, 103, 107, 112, 114, 129, 131, 136, 145
7g. Cellofas (77), Hercules CMC (72), Midland (88)	4, 34, 52, 72, 77, 88
8. Arcco (32), Bondmaster (123), Bunarex (104), Cumar (26), Fuller (61), Gripweld (4), Loxite (146), Midland (88), Miracle (90), Nevindene (98), Nevillac (98), Neville (98), Nuba (98), Ohio (102), Paradene (98), Picco (104), Piccoumaron (104), Piccovar (104), Placco (32), Polybond (114), Reslac (32), Resyn (95), Rez-N-Bond (126), Upaco (136), Velsicol (142)	4, 14, 15, 19, 26, 32, 33, 61, 71, 76, 88, 90, 95, 98, 102, 104, 107, 112, 114, 123, 126, 136, 142, 145, 146
9. Adgrip (4), Alfane (21), Alk-O-Flex (7), Amphesive (21), Araldite (42), Aritemp (17), Bakelite (25), Bond (30), Bonding Agent (28), Bondmaster (123), BRC (29), Brushmaster (123), Carboline (36), Cardolite (79), CD Cement (40), Cellobond (33), Chemo Tec (114), Cordo-Bond (45), Corrocote (39), Cycleweld (47), Duro-lok (95), Ecco (55), Epibond (62), Epiphen (32), Epocast (62), Epolac (81), Epon (128), Epoxylite (56), B.F. Goodrich (67), Hysol (75), Lithgow (83), Loven (84), Marblette (86), Metalfil (3), Metlbond (94), Midland (88), Miracle (90), Multiplastics (93), Narmco (94), National Casein (96), Nepoxide (21), Nureco (101), Ohio (102), Paisley (103), Plymaster (123), Polyox (118), Poly-Preg (111), Polytool (118), Pylene (114), Ren (119), Resiweld (61), Stabond (9), Styrobond (94), Styroseal (94), Tygofil (139), Tygoweld (139), 3 M (89)	3, 4, 7, 9, 14, 17, 19, 20, 21, 23, 25, 28, 29, 30, 32, 33, 36, 39, 40, 42, 47, 55, 56, 57, 58, 61, 62, 67, 75, 76, 79, 81, 83, 84, 85, 86, 88, 89, 90, 93, 94, 95, 96, 101, 102, 103, 107, 111, 112, 114, 118, 119, 123, 128, 129, 139, 145
10. Alkaloy (21), Alkor (21), Atlas (21), Carboline (36), Corrocote (39), Duralon (139), Durez (53), Fura-Tone (79), Furnane (21), Helix (28), Loven (84), Plenco (109), Resin X (62), Synvar (133), Varcum (141)	21, 28, 36, 39, 53, 62, 79, 84, 85, 96, 109, 133, 139, 141
11. Fedrogum (58), Fuller (61), Hallmark (130), Midland (88), Polybond (114), Solubic (103), Upaco (136)	46, 58, 61, 88, 95, 99, 103, 114, 129, 130, 131, 136
12. Bondmaster (123), JC (21), Loxite (146), Midland (88), Miracle (90), Nebony (98), Neville (98), Ohio (102), Panarez (13), Piccopale (104), Polybond (114), Resyn (95), Velsicol (142)	13, 21, 32, 71, 76, 88, 90, 95, 98, 102, 104, 107, 112, 114, 123, 129, 142, 144, 145, 146
13. API (5), Arcco (32), Bondmaster (123), Fuller (61), B.F. Goodrich (67), Loxite (146), Midland (88), Oppanol B (100), Placco (32), Plastic (103), Polybond (114), Reslac (32), Resyn (95), Upaco (136)	5, 14, 15, 32, 52, 61, 67, 76, 88, 95, 100, 103, 112, 114, 116, 123, 136, 144, 145, 146

[b] Code for solvents: A = Alcohols; Cl = Chlorinated hydrocarbons; E = Fatty acid esters; H = Aromatic hydrocarbons; HA = Aliphatic hydrocarbons; K = Ketones; W = Water (solution or emulsion).

[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor.

TYPE OF PLASTIC BASE	BONDING CLASSIFICATION[a]	SOLVENTS[b]	RESISTANCE RATING[c]					EFFECTIVENESS[c] OF BOND WITH:							
			Water	Solvents	Heat	Cold	Fungus	Wood	Metals	Rubber	Glass	Leather	Paper	Textiles	Ceramics
14. Isocyanate resins (polyurethanes)	H, R, M	Cl, E, H, K	E	E	E	E	E	E	E	E	E	E	E	E	E
15. Melamine resins															
15a. Melamine-formaldehyde	H	A, W	E	E	E	E	E	E	P	P	P	G	E	E	F
15b. Melamine-urea-formaldehyde	H	W	E	E	E	E	E	E	P	E	P	E	E	E	M
16. Oleo-resins	SR, R	H	G	G	G	M	E	G	G	P	G	G	G	G	G
17. Phenolic resins															
17a. Phenol-formaldehyde	R	A, K, W	–	E	G	G	E	M	P	E	P	M	M	M	G
	M	A, K, W	E	E	E	E	E	E	P	E	P	G	G	G	G
	H	A, K, W	E	E	E	E	E	E	P	E	P	E	E	E	G
17b. Phenolic-elastomer	SR, R	Cl, K	E	G	G	E	E	E	G	G	G	E	E	E	G
	M	Cl, K	E	G	G	E	E	G	M	G	G	G	E	G	G
	F, H	Cl, K	E	E	E	E	E	E	E	G	G	G	E	E	E
17c. Phenolic-epoxy	H	None needed	E	E	E	E	E	E	E	F	E	E	G	E	E
17d. Phenolic-polyamide	F, H	A	P	F	M	E	E	E	E	P	P	F	P	F	F
17e. Phenolic-vinyl acetals	M, H	A, H, K	E	E	G	M	E	E	E	G	F	G	E	E	E
18. Polyamide resins															
18a. Polyamides	SR, F	Alcohols > C_2	E	G	M	G	E	E	E	–	G	G	E	G	G
18b. Polyamide-epoxy	M, R, SR	None or A + K	E	E	G	E	E	E	E	G	E	E	E	E	E
19. Polyester resins															
19a. Polyesters (unsaturated)	H	A, E, H, K	G	E	M	M	E	M	E	F	E	M	E	E	M
19b. Polyester-elastomer	H, R	None needed	E	E	E	M	E	E	F	M	G	E	E	E	M
—Polyisobutylene (see Isobutylene resins)															
20. Resorcinol resins															
20a. Resorcinol-formaldehyde	R	A, K, W	E	E	E	E	E	E	P	E	P	E	E	E	G
	M	A, K, W	E	E	E	E	E	E	P	E	P	E	E	E	G
20b. Resorcinol-furfural	R	A, W	E	E	E	E	E	E	P	E	P	G	E	E	F
20c. Resorcinol-phenol-formaldehyde	R	A, K, W	E	E	E	E	E	E	P	E	P	E	E	E	G
	M	A, K, W	E	E	E	E	E	E	P	E	P	E	E	E	G
20d. Resorcinol-polyamide	R	A, W	E	E	E	E	E	E	F	E	F	E	E	E	M
20e. Resorcinol-urea	M	W	G	E	G	G	E	G	P	G	P	E	E	E	M
21. Rubbers															
21a. Natural rubber	SR	Cl, H, HA, W	G	F	F	G	E	F	M	G	G	G	G	G	F
	V	Cl, H, HA, W	G	M	M	G	E	F	F	E	G	G	G	E	F
21b. Reclaimed rubber	SR	Cl, H, HA, W	E	F	F	G	E	G	G	G	M	G	G	E	E
	V	Cl, H, W	M	F	G	G	E	G	M	G	M	G	G	E	F
21c. Chlorinated rubber	SR, F	E, H, K	M	P	M	M	E	M	M	M	M	M	G	G	P
21d. Cyclized rubber	SR, F	Cl, H	E	F	F	M	E	F	M	E	P	P	E	E	P

[a] Code for bonding classification: SR = Solvent released (from solution or emulsion); F = Fused by heating; V = Vulcanized; R = Cured at room temperature (70–80°F.); M = Cured at moderate temperature (150–200°F.); H = Cured at elevated temperature (275–310°F.); CR = Chemically reacted.

TRADE DESIGNATIONS	MANUFACTURERS OR SUPPLIERS OF RESINS OR ADHESIVES *(See list on pp. 570–1 for key to numbers)*
14. Adlok (4), Bondmaster (123), Cyfoam (21), Epolac (81), Flexweld (135), B.F. Goodrich (67), Loven (84), Mondur (91), Mondur/Multron (91), Multranil (91), Polylite (118), Uresive (21), Vulcabond (77)	4, 21, 24, 32, 33, 34, 67, 77, 81, 84, 85, 91, 112, 118, 123, 135, 145
15.	
15a. Cymel (8), Lauxite (92)	8, 33, 57, 85, 92, 105, 145
15b. Lauxite (92), Melurac (8), Uformite (121)	8, 33, 92, 96, 105, 121, 145
16. Bondmaster (123), Lithgow (83), Midland (88), Miracle (90), Ohio (102), Paisley (103), 3 M (89)	19, 58, 59, 61, 83, 88, 89, 90, 102, 103, 123, 145
17.	
17a. Acme (1), Amberlite (121), Amres (11), Bakelite (25), Bedesol (77), Bondmaster (123), Cascophen (32), Catalin (37), Cellobond (33), Durez (53), Durite (32), Forasite (118), Fuller (61), B.F. Goodrich (67), Heresite (73), Korez (21), Lauxite (92), Lebec (82), Loven (84), Loxite (146), Marblette (86), Marbon (87), Midland (88), National Casein (96), Nobellac (118), Paisley (103), Plaskon (26), Plasticweld (83), Plenco (109), Plyophen (118), Rubbagrip (122), Schenectady (125), Stixgrip (4), Synco (132), Synvarite (133), Tego (121), Tybon (31), Upaco (136), Varcum (141), 3 M (89)	1, 4, 11, 14, 19, 21, 25, 26, 31, 32, 33, 34, 37, 53, 57, 61, 64, 67, 73, 77, 82, 83, 84, 85, 86, 87, 88, 89, 92, 96, 103, 105, 109, 112, 118, 121, 122, 123, 125, 132, 133, 136, 141, 145, 146
17b. Bondmaster (123), Bostik (24), BRC (29), Compo (44), Corrocote (39), Cycleweld (47), Dennis (48), Durite (32), FM (29), Fuller (61), Glu-Ply (76), Lauxite (92), Loxite (146), Metlbond (94), Midland (88), Narmtape (94), Permabond (112), Plastilock (67), Pliobond (68), Pliogrip (68), Pliotac (68), Pliotemp (68), Plymaster (123), Polybond (114), Redux (42), Resyn (95), RS (87), Rubbagrip (122), Stabond (9), Stixgrip (4), Upaco (136), 3 M (89)	4, 9, 14, 19, 24, 29, 32, 39, 42, 44, 47, 48, 67, 68, 76, 81, 82, 87, 89, 92, 94, 95, 107, 112, 114, 122, 123, 132, 133, 136, 145, 146
17c. Aerobond (3), BRC (29), Lebec (82), Metlbond (94), Plenco (109), Tygoweld (139)	3, 29, 82, 94, 109, 139
17d. Alk-O-Flex (7), Bondmaster (123), Cycleweld (47), Lithgow (83), Metlbond (94), Midland (88), Schenectady (125)	7, 32, 47, 76, 83, 88, 94, 107, 112, 123, 125, 145
17e. Arcco (32), Bondmaster (123), Bostik (24), BRC (29), Compo (44), Cycleweld (47), B.F. Goodrich (67), Midland (88), Placco (32), Plycozite (137), Polyco (32), Redux (6), Reslac (32), Schenectady (125), Synco (132)	4, 6, 14, 19, 24, 29, 32, 44, 47, 67, 88, 107, 112, 123, 125, 132, 137, 145
18.	
18a. Adlok (4), Arcco (32), BCI (27), Bondmaster (123), CD Cement (40), Corrocote (39), Epolac (81), Fuller (61), Midland (88), Miracle (90), Nylaweld (113, 115), Ohio (102), Paisley (103), Placco (32), Plastibond (69), Polybond (114), Reslac (32), Resyn (95), Upaco (136), Versamid (66)	4, 19, 24, 27, 32, 39, 40, 61, 66, 69, 76, 81, 85, 88, 90, 95, 102, 103, 107, 113, 114, 115, 116, 123, 136, 145
18b. Adlok (4), Aerobond (3), Arcco (32), Bondmaster (123), Corrocote (39), Duro-lok (95), Epolac (81), Hysol (75), Metalfil (3), Midland (88), Miracle (90), Narmco (94), Nureco (101), Ohio (102), Placco (32), Plastibond (69), Reslac (32)	3, 4, 14, 30, 32, 39, 48, 66, 69, 75, 76, 81, 88, 90, 94, 95, 101, 102, 123, 145
19.	
19a. Bonding Agent (28), Bondmaster (123), Cellobond (33), Daltolac (77), Loven (84), Multiplastics (93), Nureco (101), Polylite (118)	4, 28, 32, 33, 34, 38, 52, 58, 77, 84, 93, 101, 118, 123, 129
19b. Ampreg (21), Atlac (22), Carboline (36), Hexaplas (77), Marco Resin (38), Parsplex (121), Plaskon (26), Plastaloy (21), Polylite (118), Selectron (108), Synvar-V (133)	2, 21, 22, 26, 32, 34, 36, 38, 77, 108, 118, 121, 133, 145
20.	
20a. Amberlite (121), Amres (11), Bostik (24), Cascophen (32), Catalin (37), CD Cement (40), Cellobond (33), Cordo-Bond (45), Durez (53), Durite (32), B.F. Goodrich (67), Lauxite (92), Lotol (97), Loxite (146), National Casein (96), Paisley (103), Penacolite (80), Plyophen (118), Resinox (92), Resorsabond (11), Rezoform (112), Schenectady (125), Synco (132), Synvaren (133)	11, 14, 24, 32, 33, 37, 40, 53, 67, 80, 85, 92, 96, 97, 103, 105, 112, 118, 121, 125, 132, 133, 145, 146
20b. Durite (32)	32, 132
20c. Amres (11), Bakelite (25), Cascophen (32), Catalin (37), Durez (53), Lauxite (92), National Casein (96), Penacolite (80), Plyophen (118), Resinox (92), Resorsabond (11), Synvarite (133)	4, 11, 14, 25, 32, 33, 37, 53, 80, 92, 96, 105, 112, 118, 132, 133, 137, 145
20d. Bondmaster (123), Penacolite (80)	80, 123, 145
20e. Casco-Resin (32), National Casein (96), Plaskon (26), Synvarol (133), Uformite (121)	26, 32, 105, 121, 132, 133, 145
21.	
21a. Adco (4), Adrub (4), Anodex (67), API (5), Arcco (32), Baytex (135), Bond (30), Bondmaster (123), Bondrite (135), Bostik (24), BRC (29), Brushmaster (123), Casco (32), Compo (44), Dab-it (129), Darex (49), Dennis (48), Farrington (57), Fedco (58), Fedrobond (58), Fuller (61), B.F. Goodrich (67), Inceloid (12), Laco (81), Lebec (82), Lotol (97), Loxite (146), Midland (88), Miracle (90), Ohio (102), Permaweld (112), Placco (32), Plastite (110), Pliastic (103), Pliotex (88), Polybond (114), Reslac (32), Resyn (95), Rubbagrip (122), Rubbatex (122), Stabond (9), Thixon (71), Treadmaster (123), Triple (14), Typly (87), U-Glu (129), Upaco (136), Vultex (65), 3 M (89)	4, 5, 9, 12, 14, 15, 19, 24, 29, 30, 32, 44, 48, 49, 57, 58, 61, 65, 67, 71, 76, 81, 82, 85, 87, 88, 89, 90, 95, 96, 97, 102, 103, 110, 112, 114, 122, 123, 124, 129, 135, 136, 144, 145, 146
21b. Adflex (4), Arcco (32), Bondmaster (123), Bostik (24), BRC (29), Casco (32), Cycleweld (47), Disperaite (97), Fuller (61), Indu-Sealz (97), Iron Bound (129), Loxite (146), Midland (88), Miracle (90), Ohio (102), Permaweld (112), Placco (32), Plastikon (67), Plastite (110), Pliastic (103), Pliotex (88), Polybond (114), Reslac (32), Resyn (95), Rubbatex (122), Thixon (71), Upaco (136), 3 M (89)	4, 14, 19, 24, 29, 32, 47, 61, 67, 71, 88, 89, 90, 95, 97, 102, 103, 110, 112, 114, 122, 123, 129, 131, 136, 138, 145, 146
21c. Adweld (4), Alloprene (77), Arcco (32), Bondmaster (123), Bostik (24), BRC (29), Carboline (36), CD Cement (40), Laco (81), Loven (84), Midland (88), Miracle (90), Ohio (102), Parlon (72), Permaweld (112), Placco (32), Plastilock (67), Plastite (110), Pliastic (103), Polybond (114), Reslac (32), Rubbagrip (122), Stabond (9), Texkote (111), Typly (87), Upaco (136), Zerok (21)	4, 9, 14, 19, 21, 24, 29, 32, 34, 36, 40, 58, 67, 72, 76, 77, 81, 84, 88, 90, 102, 103, 107, 110, 111, 112, 114, 116, 122, 123, 135, 136, 145
21d. Alpex (7), Bondmaster (123), Bostik (24), Fuller (61), Permaweld (112), Pliastic (103), Polybond (114), Reanite (139), Typly (87), Vulcalock (67)	4, 7, 14, 24, 32, 61, 67, 103, 107, 112, 114, 116, 123, 135, 136, 139, 145

[b] Code for solvents: A = Alcohols; Cl = Chlorinated hydrocarbons; E = Fatty acid esters; H = Aromatic hydrocarbons; HA = Aliphatic hydrocarbons; K = Ketones; W = Water (solution or emulsion).

[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor.

TYPE OF PLASTIC BASE	BONDING CLASSIFICATION[a]	SOLVENTS[b]	RESISTANCE RATING[c]					EFFECTIVENESS[c] OF BOND WITH:							
			Water	Solvents	Heat	Cold	Fungus	Wood	Metals	Rubber	Glass	Leather	Paper	Textiles	Ceramics
21e. Butadiene-acrylonitrile rubber	SR, F	Cl, H, K, W	G	E	G	G	E	G	E	G	G	G	G	E	M
	V	Cl, H, K	G	E	G	M	E	G	E	G	G	G	G	E	M
21f. Butadiene-styrene rubber	SR, V	Cl, H, HA, K, W	G	F	M	M	E	G	M	G	M	G	E	E	F
21g. Butyl rubber	SR	H, W	G	F	G	M	G	F	M	G	M	G	E	E	M
	V	H	G	F	G	M	G	F	M	M	M	G	E	E	F
21h. Neoprene rubber (polychloroprene)	SR, R	Cl, E, H, HA, K, W	E	G	G	G	E	E	E	E	E	E	E	E	E
	V	Cl, E, H, K	E	G	E	G	E	E	G	E	P	E	E	E	F
21i. Polysulfides (Thiokol)	SR	Cl, H, W	M	M	M	M	E	M	F	M	F	M	M	M	P
	CR	Cl, H	M	G	G	G	E	M	G	E	G	G	G	G	M
21j. Polysulfide-epoxy	CR, M, K	None	E	E	G	E	E	E	E	G	E	E	E	E	E
22. Shellac	F, SR	A	G	P	M	G	E	E	E	G	E	E	E	E	F
23. Silicone polymers															
23a. Silicone resins	H	H, K	E	F	E	G	G	–	G	–	G	–	–	–	G
23b. Silicone rubbers	R, V	H	G	P	G	E	E	–	E	–	E	–	–	E	E
24. Sodium silicate	M, SR	W	P	E	E	G	E	G	G	P	E	F	E	G	E
25. Soybean glue	SR	W	P	M	F	P	F	F	P	P	F	F	G	M	P
26. Starch and dextrin	SR	W	P	M	F	F	P	F	P	P	P	M	M	M	P
27. Styrene resins (polystyrene)	SR, F	Cl, E, H, K, W	E	M	M	G	E	G	P	M	P	G	E	G	F
28. Terpene resins	SR, F	Cl, E, H, HA, W	E	P	F	M	E	M	G	G	G	G	G	G	F
29. Urea resins															
29a. Urea-formaldehyde	R	W	M	E	M	E	E	E	P	P	P	G	E	E	P
	H	W	G	E	M	E	E	E	P	P	P	G	E	G	P
29b. Urea-formaldehyde-furfuryl alcohol	R	W	G	E	M	E	E	E	P	P	P	G	E	E	P
—Urethanes (see Isocyanate resins)															
30. Vinyl resins															
30a. Vinyl acetal	SR, F	A, E, H	G	M	F	G	E	G	E	M	E	E	E	E	G
30b. Vinyl acetate or vinyl alcohol-acetate	SR, F	A, Cl, E, H, K, W	F	M	M	M	E	E	E	P	E	E	E	E	E
30c. Vinyl acetate copolymer	SR	A, Cl, E, H, K, WA	G	M	M	M	E	G	G	F	G	G	G	G	G
30d. Vinyl alcohol	SR	A, W	F	E	G	M	E	M	P	P	P	G	E	G	G
30e. Vinyl alkyl ether	SR, F	A, Cl, E, H, K, W	G	P	F	G	E	G	G	F	F	F	G	G	F
30f. Vinyl methyl ether-maleic anhydride copolymer	SR, F, CR	A, E, K, W	P	P	G	G	E	G	E	F	G	E	E	E	E

[a] Code for bonding classification: SR = Solvent released (from solution or emulsion); F = Fused by heating; V = Vulcanized; R = Cured at room temperature (70–80°F.); M = Cured at moderate temperature (150–200°F.); H = Cured at elevated temperature (275–310°F.); CR = Chemically reacted.

	TRADE DESIGNATIONS	MANUFACTURERS OR SUPPLIERS OF RESINS OR ADHESIVES *(See list on pp. 570–1 for key to numbers)*
21e.	Adweld (4), Anodex (67), API (5), Arcco (32), Bond (30), Bondmaster (123), Bostik (24), BRC (29), Brushmaster (123), Carboline (36), Compo (44), Fedco (58), Fuller (61), Gripweld (4), Laco (81), Loxite (146), Marbon (87), Metlbond (94), Midland (88), Miracle (90), Narmtape (94), Nitrex (97), Ohio (102), Permaweld (112), Placco (32), Plastibond (69), Plastilock (67), Plastite (110), Pliastic (103), Pliobond (68), Pliogrip (68), Polybond (114), Polyco (32), Reslac (32), Resyn (95), Rez-N-Bond (126), Rubbagrip (122), Thixon (71), Tweezle (30), Tygobond (139), Tygoweld (139), Typly (87), Ubabond (135), Upaco (136), 3 M (89)	4, 5, 14, 19, 24, 29, 30, 32, 36, 44, 52, 58, 61, 65, 67, 68, 69, 71, 76, 81, 87, 88, 89, 90, 94, 95, 96, 97, 102, 103, 107, 110, 112, 114, 116, 122, 123, 124, 126, 135, 136, 138, 139, 144, 145, 146
21f.	Adprene (4), Anodox (67), API (5), Arcco (32), Baytex (135), Bondmaster (123), Bostik (24), BRC (29), Casco (32), Cycleweld (47), Farrington (57), Fedco (58), Fedrobond (58), Fuller (61), B.F. Goodrich (67), Kralac (97), Kralastic (97), Laco (81), Loxite (146), Midland (88), Miracle (90), Naugapol (97), Naugatex (97), Ohio (102), Permaweld (112), Placco (32), Plastite (110), Pliastic (103), Pliogrip (68), Pliotex (88), Polybond (114), Polyco (32), Reslac (32), Resyn (95), Rubbatex (122), Typly (87), Ubapol (135), Upaco (136), Zerok (21), 3 M (89)	4, 5, 14, 19, 21, 24, 29, 30, 32, 47, 57, 58, 61, 65, 67, 68, 76, 81, 88, 89, 90, 95, 97, 102, 103, 107, 110, 112, 114, 116, 122, 123, 124, 131, 135, 136, 138, 144, 145, 146
21g.	API (5), Arcco (32), Bondmaster (123), Bostik (24), BRC (29), Dispersite (97), Fuller (61), B.F. Goodrich (67), Gripweld (4), Inceloid (12), Laco (81), Lebec (82), Loxite (146), Midland (88), Miracle (90), Ohio (102), Permaweld (112), Placco (32), Plastite (110), Pliastic (103), Polybond (114), Reslac (32), Resyn (95), Thixon (71), Typly (87), Upaco (136), 3 M (89)	4, 5, 12, 14, 19, 24, 29, 32, 61, 67, 71, 76, 81, 82, 88, 89, 90, 95, 97, 102, 103, 107, 110, 112, 114, 116, 123, 136, 138, 145, 146
21h.	Adweld (4), Ampkote (21), Anodex (67), API (5), Arcco (32), Baytex (135), Bondmaster (123), Bostik (24), BRC (29), Carboline (36), Casco (32), Compo (44), Cycleweld (47), Darex (49), Dennis (48), Elprene (21), Fairprene (52), Fedco (58), Fedrobond (58), Formica Fasdri Contact Bond (60), Fuller (61), B.F. Goodrich (67), Gripweld (4), Laco (81), Lebec (82), Lotol (97), Loxite (146), Midland (88), Miracle (90), Neelium (21), Neobon (21), Nu-Rub (4), Ohio (102), Permaweld (112), Placco (32), Plastite (110), Pliastic (103), Pliobond (68), Pliotex (88), Polybond (114), Reslac (32), Resyn (95), Rubbagrip (122), Stabond (9), Stix (4), Stixgrip (4), Thixon (71), Typly (87), Ubagrip (135), Upaco (136), U-Sement (138), 3 M (89)	4, 5, 9, 14, 15, 19, 21, 24, 29, 32, 36, 44, 47, 48, 49, 52, 58, 60, 61, 65, 67, 68, 71, 76, 81, 82, 88, 89, 90, 95, 97, 102, 103, 107, 110, 112, 114, 122, 123, 124, 129, 135, 136, 138, 145, 146
21i.	Bondmaster (123), Casco (32), Loven (84), Permaweld (112), Polybond (114), Thioment (21), 3 M (89)	19, 21, 24, 32, 84, 89, 112, 114, 123
21j.	Aerobond (3)	3
22.	Midland (88)	14, 88, 114, 136, 147
23.		
23a.	Dow Corning (51), Plastite (110)	51, 64, 85, 110
23b.	Dow Corning (51), Polybond (114)	51, 64, 107, 114
24.	API (5), Loven (84), Midland (88), Paisley (103), Polybond (114), Stixso (106), Vitrex (21)	4, 5, 21, 52, 58, 76, 84, 88, 103, 106, 114, 129
25.	A-M (11), API (5), Casco (32), Lauxein (92), Paisley (103), Piyacien (118), Polybond (114), Upaco (136)	5, 11, 16, 32, 92, 103, 114, 136
26.	Adex (58), API (5), Argo Polyose (46), Bent-Tite (105), Cascola (32), Corox (105), Fedex (58), Fuller (61), Hallmark (130), Loxite (146), Midland (88), Polybond (114), Residex (103), Speedyset (144), Upaco (136)	4, 5, 15, 16, 19, 24, 32, 46, 58, 61, 76, 85, 88, 95, 103, 105, 114, 129, 130, 131, 136, 144, 146
27.	Ampcolite (21), Arcco (32), Bakelite (25), Bond (30), Bondmaster (123), Catalin (37), CD Cement (40), Cellobond (33), Farrington (57), Fuller (61), Inceloid (12), Koppers (80), Midland (88), Piccolastic (104), Placco (32), Polybond (114), Polyco (32), Reslac (32), Rez-N-Bond (126), Rez-N-Glue (126), Rubbagrip (122), Styfil (4), Styrogrip (4), Ubatol (135), Upaco (136), 3 M (89)	4, 12, 14, 15, 21, 24, 25, 30, 32, 33, 37, 40, 50, 57, 58, 61, 71, 76, 80, 85, 88, 89, 92, 104, 112, 114, 116, 117, 122, 123, 126, 135, 136, 145
28.	API (5), Arcco (32), Bondmaster (123), Dispersite (97), Loxite (146), Midland (88), Piccolyte (104), Placco (32), Polybond (114), Reslac (32), Schenectady (125)	5, 32, 33, 71, 76, 88, 97, 104, 107, 114, 123, 125, 145, 146
29.		
29a.	Amres (11), Bakelite (25), Cascamite (32), Casco-Resin (32), Catalin (37), Cellobond (33), Formica Urac (60), Fuller (61), Ful-O-Mite (61), Griptite (4), Holdbest (74), Lauxite (92), Lebec (82), Loven (84), Midland (88), National Casein (96), Paralac (77), Permaweld (112), Plaskon (26), Piyamine (118), Polybond (114), Residex (103), Synco (132), Synvarol (133), Uformite (121), Urac (8), Uraform (112), Weldwood (137)	4, 8, 11, 25, 26, 32, 33, 34, 37, 60, 61, 74, 77, 82, 84, 88, 92, 96, 103, 105, 112, 114, 118, 121, 130, 132, 133, 136, 137, 145
29b.	Casco-Resin (32), National Casein (96), Plaskon (26), Piyamine (118), Urac (8)	8, 26, 32, 33, 96, 118, 132
30.		
30a.	Alvar (127), Bakelite (25), Bondmaster (123), Bostik (24), BRC (29), Compo (44), Fedco (58), Midland (88), Plastibond (69), Plymaster (123), Polybond (114), Upaco (136), U-Sement (138), Vinylgrip (4)	4, 14, 19, 24, 25, 29, 44, 52, 58, 67, 69, 88, 92, 97, 107, 112, 114, 123, 126, 127, 136, 145
30b.	Acetex (97), Alk-o-mer (7), API (5), Arcco (32), Bakelite (25), Bond (30), Bondmaster (123), Bostik (24), Cascorez (32), CD Cement (40), Cellobond (33), Compo (44), Darex (49), Dennis (48), Elvacet (52), Fedco (58), Federez (58), Fuller (61), Gelva (127), B.F. Goodrich (67), Griffin (70), Hallmark (130), Helix (28), Hewhold (74), Hu-Rez (76), Inceloid (12), Kotol (97), Kwik-Klamp (95), Lauxite (92), Lemac (32), Midland (88), Miracle (90), National Casein (96), Ohio (102), Placco (32), Plastibond (69), Plasticweld (83), Plastigrip (4), Plastite (110), Pliastic (103), Plyamul (118), Polybond (114), Polyco (32), Resgrip (4), Resiwood (61), Reslac (32), Resyn (95), Rez-N-Glue (126), Rubbagrip (122), Sobo (129), Speedbond (92), Syn-tite (88), Synvac (132), Upaco (136), U-Sement (138), VC (126), Velverette (129), Vinac (43), Vinylgrip (4), Vinymul (103)	2, 4, 5, 7, 10, 12, 14, 15, 18, 19, 23, 24, 25, 28, 30, 32, 33, 40, 43, 44, 48, 49, 52, 57, 58, 61, 67, 69, 70, 74, 76, 83, 85, 88, 90, 92, 95, 96, 97, 102, 103, 105, 107, 110, 111, 112, 114, 116, 117, 118, 120, 122, 123, 126, 127, 129, 130, 131, 132, 136, 138, 144, 145
30c.	API (5), Arcco (32), Bondmaster (123), Elvalan (52), Fedco (58), Flexbond (43), B.F. Goodrich (67), Lemac (32), Midland (88), Paisley (103), Placco (32), Plastibond (69), Polybond (114), Polyco (32), Resgrip (4), Reslac (32), Resyn (95), Upaco (136), VC (126), Vinylgrip (4)	4, 5, 24, 30, 32, 52, 58, 67, 69, 76, 88, 95, 103, 114, 116, 117, 123, 126, 129, 136, 145
30d.	API (5), Elvanol (52), Fedco (58), Fedcol (58), Fuller (61), Gelvatol (127), B.F. Goodrich (67), Hallmark (130), Lemol (32), Midland (88), Pliastic (103), Polybond (114), Resgrip (4), Resiflex (61), Resyn (95), Syn-tite (88), Upaco (136), Vinol (43), Vinylgrip (4)	4, 5, 15, 19, 32, 43, 52, 58, 61, 67, 76, 88, 95, 103, 107, 112, 114, 127, 129, 130, 131, 136, 144, 145
30e.	Bakelite (25), Bondmaster (123), Polybond (114), PVM (63), Resyn (95), Upaco (136)	14, 25, 63, 95, 114, 123, 136, 144, 145
30f.	Polybond (114), PVM/MA (63)	63, 114

[b] Code for solvents: A = Alcohols; Cl = Chlorinated hydrocarbons; E = Fatty acid esters; H = Aromatic hydrocarbons; HA = Aliphatic hydrocarbons; K = Ketones; W = Water (solution or emulsion).

[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor.

TYPE OF PLASTIC BASE	BONDING CLASSIFICATION[a]	SOLVENTS[b]	RESISTANCE RATING[c]					EFFECTIVENESS[c] OF BOND WITH:							
			Water	Solvents	Heat	Cold	Fungus	Wood	Metals	Rubber	Glass	Leather	Paper	Textiles	Ceramics
30g. Vinyl chloride	SR, F	A	M	M	M	M	E	E	E	G	E	E	E	E	E
30h. Vinyl butyral	SR, F	E, W	G	M	F	M	E	M	G	G	G	E	E	E	G
30i. Vinyl chloride-acetate copolymer	SR, F	E, K	E	G	G	G	E	G	G	M	G	E	F	E	G
30j. Vinyl pyrrolidone	SR, H	A, Cl, E, H, K, W	P	P	G	G	G	M	M	G	E	E	E	E	E
30k. Vinylidene chloride copolymer	SR, F	E, K, W	E	G	F	G	E	M	G	M	G	E	E	E	G
31. Waxes, modified	F	H	E	P	P	G	E	M	P	P	P	G	E	E	P
32. Zein	CR, H	A, W	M	G	G	G	G	E	F	P	F	E	E	E	F
	SR	A, W	F	F	G	G	G	G	F	P	F	G	G	G	F

[a] Code for bonding classification: SR = Solvent released (from solution or emulsion); F = Fused by heating; V = Vulcanized; R = Cured at room temperature (70–80°F.); M = Cured at moderate temperature (150–200°F.); H = Cured at elevated temperature (275–310°F.); CR = Chemically reacted.

LIST OF MANUFACTURERS AND SUPPLIERS OF RESINS AND ADHESIVES*

1. Acme Resin Corp., 1401 Circle Ave., Forest Park, Ill. (A)
2. Acryvin Corp. of America, 470 E. 99th St., Brooklyn 36, N.Y. (A)
3. Adhesive Engineering, San Carlos, Calif. (A)
4. Adhesive Products Corp., New York 60, N.Y. (RA)
5. Adhesive Products Inc., Albany 10, Calif. (A)
6. Aero Research, Ltd., Cambridge-Duxford, England (A)
7. Alkydol Laboratories, Inc., Cicero 50, Ill. (RA)
8. American Cyanamid Co., Plastics and Resins Div., 30 Rockefeller Plaza, New York 20, N.Y. (RA)
9. American Latex Products Corp., Hawthorne, Calif. (A)
10. American Lucoflex Inc., 500 5th Ave., New York 36, N.Y. (A)
11. American-Marietta Co., Adhesive, Resin and Chemical Div., 3400 13th Ave., S.W., Seattle 4, Wash. (RA)
12. American Products Manufacturing Co., New Orleans 18, La. (A)
13. Amoco Chemicals Corp., 910 S. Michigan Ave., Chicago 80, Ill. (R)
14. Angier Adhesives, Div. of Interchemical Corp., 120 Potter St., Cambridge 42, Mass. (A)
15. Arabol Mfg. Co., 110 E. 42nd St., New York 17, N.Y. (A)
16. Archer-Daniels-Midland Co., Minneapolis 2, Minn. (A)
17. Aries Laboratories, Inc., New York 17, N.Y. (A)
18. Armour and Co., 1355 W. 31st St., Chicago 9, Ill. (A)
19. Armstrong Cork Co., Lancaster, Pa. (A)
20. Armstrong Products Co., P.O. Box 1, Warsaw, Ind. (A)
21. Atlas Mineral Products Co., Mertztown, Pa. (A)
22. Atlas Powder Co., Wilmington 99, Del. (A)
23. Atlas Synthetics Corp., Long Island City 1, N.Y. (R)
24. B.B. Chemical Co., 784 Memorial Drive, Cambridge 39, Mass. (A)
25. Bakelite Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y. (RA)
26. Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y. (RA)
27. Belding Corticelli Industries, Chemicals Div., 1407 Broadway, New York 18, N.Y. (R)
28. Biggs Co., Inc., Carl H., Los Angeles 64, Calif. (A)
29. Bloomingdale Rubber Co., Aberdeen, Md. (A)
30. Bond Adhesives Co., Box 406, Main P.O., Jersey City 3, N.J. (A)
31. Booty Resineers, Inc., 112 Jefferson St., Newark, Ohio (R)
32. Borden Co., The, Chemical Div., 350 Madison Ave., New York 17, N.Y. (RA)
33. British Resin Products Ltd., London S.W. 1, England (A)
34. Canadian Industries Ltd., Montreal, Canada (R)
35. Carbide and Carbon Chemicals Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y. (RA)
36. Carboline Co., 331 Thornton Ave., St. Louis 19, Mo. (A)
37. Catalin Corp., 1 Park Ave., New York 16, N.Y. (RA)
38. Celanese Corp. of America, Plastics Div., 290 Ferry St., Newark 5, N.J. (RA)
39. Chemical Coatings and Engineering Co., Inc., Edgemont, Pa. (A)
40. Chemical Development Corp., Danvers, Mass. (A)
41. Chemical Process Co., 901 Spring St., Redwood City, Calif. (R)
42. Ciba Co., Inc., Plastics Div., Kimberton, Pa. (R)
43. Colton Chemical Co., 1747 Chester Ave., Cleveland 14, Ohio (R)
44. Compo Chemical Co., Inc., Boston 14, Mass. (A)
45. Cordo Chemical Co., 34 Smith St., Norwalk, Conn. (A)
46. Corn Products Sales Co., Chemical Div., New York 4, N.Y. (A)
47. Cycleweld Cement Products Div., Chrysler Corp., 5437 W. Jefferson, Trenton, Mich. (A)
48. Dennis Chemical Co., 2701 Papin St., St. Louis 3, Mo. (A)
49. Dewey and Almy Chemical Co., Div. of W.R. Grace and Co., Cambridge 40, Mass. (A)
50. Dow Chemical Co., The, Midland, Mich. (RA)
51. Dow Corning Corp., Midland, Mich. (RA)
52. E.I. duPont de Nemours and Co., Wilmington 98, Del. (RA)
53. Durez Plastics Div., Hooker Electrochemical Co., 888 Walck Road, North Tonawanda, N.Y. (RA)
54. Eastman Chemical Products, Inc., Kingsport, Tenn. (R)
55. Emerson and Cuming, Inc., Canton, Mass. (A)
56. Epoxylite Corp., El Monte, Calif. (A)
57. Farrington Texol Corp., Walpole, Mass. (A)
58. Federal Adhesives Corp., 210 Wythe Ave., Brooklyn 11, N.Y. (A)
59. Flintkote Co., Atlas Adhesives Div., Philadelphia 27, Pa. (A)
60. Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio (A)
61. H.B. Fuller Co., 181 W. Kellogg Blvd., St. Paul 2, Minn. (A)
62. Furane Plastics Inc., Los Angeles 39, Calif. (RA)
63. General Aniline and Film Corp., New York 14, N.Y. (R)
64. General Electric Co., Pittsfield, Mass. (RA)
65. General Latex and Chemical Corp., Cambridge 39, Mass. (A)
66. General Mills, Inc., Chemical Div., P.O. Box 191, Kankakee, Ill. (RA)
67. B.F. Goodrich Co., 500 S. Main St., Akron 18, Ohio (RA)
68. Goodyear Tire and Rubber Co., Chemical Div., Akron 16, Ohio (A)
69. Gordon-Lacey Chemical Products Co., Maspeth, Long Island, N.Y. (A)
70. Griffin Chemical Co., Div. of Nopco Chemical Co., 1000 16th St., San Francisco 7, Calif. (R)
71. Harwick Standard Chemical Co., Akron 5, Ohio (A)
72. Hercules Powder Co., Wilmington 99, Del. (R)

*This list includes sources of bonding materials for compounding adhesives, indicated by (R), and sources of adhesive compositions prepared from the bonding materials, indicated by (A). The adhesives described on this chart are those formulated primarily with one type of plastic base. Many commercial adhesives are made up of complex mixtures of different resins in order to attain a combination of properties not found in a single type of base. The manufacturers of adhesives should be consulted before making a choice of material.

TRADE DESIGNATIONS	MANUFACTURERS OR SUPPLIERS OF RESINS OR ADHESIVES (*See list below for key to numbers*)
30g. Arcco (32), Bakelite (25), Bondmaster (123), Butvar (127), Dennis (48), Farrington (57), Laco (81), Midland (88), Placco (32), Plastibond (69), Plasticweld (83), Plastilock (67), Polybond (114), Reslac (32), Resyn (95), VC (126)	4, 24, 25, 30, 32, 48, 52, 57, 67, 69, 76, 81, 83, 88, 95, 107, 112, 114, 116, 122, 123, 126, 127, 145
30h. Ampcoflex (21), Anodex (67), Arcco (32), Bakelite (25), Bondmaster (123), Bostik (24), BRC (29), CD Cement (40), Compo (44), Cordo-Bond (45), Dennis (48), Fedco (58), Laco (81), Loven (84), Midland (88), Pee Vee Cee (21), Placco (32), Plastibond (69), Plastigrip (4), Plastilock (67), Plastite (110), Polybond (114), Polyco (32), Reslac (32), Resyn (95), Rubbagrip (122), Upaco (136), Vinylgrip (4), Watson-Standard (143)	4, 14, 19, 21, 24, 25, 29, 32, 40, 44, 48, 52, 58, 67, 69, 81, 84, 88, 95, 103, 107, 110, 112, 114, 116, 122, 123, 126, 136, 143, 145
30i. API (5), Arcco (32), Bakelite (25), Bond (30), Bondmaster (123), Bostik (24), CD Cement (40), Compo (44), Cordobond (45), Dennis (48), Fedco (58), Fuller (61), Helix (28), Hewbind (74), Kotol (97), Midland (88), Placco (32), Plastibond (69), Plastilock (67), Plastite (110), Pliastic (103), Polybond (114), Polyco (32), Reslac (32), Resyn (95), Rubbagrip (122), Stabond (9), Synco (132), Tygobond (139), Upaco (136), U-Sement (138), Vinylgrip (4), Watson-Standard (143), Zerok (21), 3 M (89)	4, 5, 9, 14, 15, 19, 21, 24, 25, 28, 30, 32, 40, 44, 48, 52, 58, 61, 67, 69, 74, 76, 78, 88, 89, 95, 97, 103, 107, 110, 112, 114, 116, 122, 123, 126, 132, 136, 138, 139, 143, 144, 145
30j. PVP (63)	63
30k. Arcco (32), Bondmaster (123), CD Cement (40), Cordo-Bond (45), Dennis (48), B.F. Goodrich (67), Midland (88), Miracle (90), Ohio (102), Placco (32), Polybond (114), Polyco (32), Reslac (32), Resyn (95), Rubbagrip (122), Saran (50), Upaco (136), Vinylgrip (4), Watson-Standard (143), 3 M (89)	4, 14, 19, 32, 40, 48, 50, 58, 67, 76, 88, 89, 90, 95, 102, 107, 112, 114, 116, 122, 123, 126, 136, 143, 145
31. API (5), Fuller (61), Indu-Sealz (97), Midland (88), Polybond (114), Resimelt (103), Reswax (32), Resyn (95), Upaco (136)	5, 14, 15, 32, 61, 88, 92, 95, 97, 103, 114, 116, 136, 145
32. Arcco (32), Argo (46), Midland (88), Paisley (103), Placco (32), Polybond (114), Reslac (32), Upaco (136)	32, 46, 88, 103, 114, 136, 145

[b] Code for solvents: A = Alcohols; Cl = Chlorinated hydrocarbons; E = Fatty acid esters; H = Aromatic hydrocarbons; HA = Aliphatic hydrocarbons; K = Ketones; W = Water (solution or emulsion).

[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor.

LIST OF MANUFACTURERS AND SUPPLIERS OF RESINS AND ADHESIVES* (*Continued*)

73. Heresite & Chemical Co., Manitowoc, Wis. (RA)
74. C.B. Hewitt and Bros., Inc., New York 13, N.Y. (A)
75. Houghton Laboratories, Inc., 322 Bush St., Olean, N.Y. (A)
76. Hughes Glue Co., Detroit 7, Mich. (A)
77. Imperial Chemical Industries Ltd., London S.W. 1, England (R)
78. Interchemical Corp., Finishes Div., 67 W. 44th St., New York 36, N.Y. (A)
79. Irvington Chemical Div., Minnesota Mining and Manufacturing Co., 500 Doremus Ave., Newark 5, N.J. (A)
80. Koppers Co., Inc., Chemical Div., Pittsburgh 19, Pa. (RA)
81. Lawrence Adhesive and Chemical Co., Lawrence, Mass. (A)
82. Lebec Chemical Corp., Paramount, Calif. (A)
83. Lithgow Chemical Co., Div. of Reichhold Engineering and Plastics Co., 12827 E. Imperial Highway, Norwalk, Calif.
84. Loven Chemical of California, Newhall, Calif. (RA)
85. Magic Chemical Co., Brockton 2, Mass. (A)
86. Marblette Corp., Long Island City 1, N.Y. (RA)
87. Marbon Chemical Div., Borg-Warner Corp., Gary, Ind. (A)
88. Midland Adhesive and Chemical Corp., Detroit 20, Mich. (A)
89. Minnesota Mining and Mfg. Co., Adhesives and Coatings Div., 411 Piquette Ave., Detroit 2, Mich. (A)
90. Miracle Adhesives Corp., 214 E. 53rd St., New York 22, N.Y. (A)
91. Mobay Chemical Co., St. Louis 4, Mo. (A)
92. Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.; Western Div., 911 Western Ave., Seattle 4, Wash. (RA)
93. Multiplastics Div., Curd Enterprises, Inc., 3337 Lincoln St., Franklin Park, Ill. (R)
94. Narmco Resins and Coatings Co., Costa Mesa, Calif. (A)
95. National Adhesives Div., National Starch Products Co., 270 Madison Ave., New York 16, N.Y. (RA)
96. National Casein Co., 601 W. 80th St., Chicago 20, Ill. (RA)
97. Naugatuck Chemical Div., U.S. Rubber Co., Naugatuck, Conn. (RA)
98. Neville Chemical Co., Neville Island, Pittsburgh 25, Pa. (R)
99. New York Quinine and Chemical Works, Inc., The, 50 Church St., New York 8, N.Y. (R)
100. Nova Chemical Corp., 147 Waverly Place, New York 14, N.Y. (R)
101. Nureco Inc., Cranston 10, R.I. (RA)
102. Ohio Adhesives Corp., New Philadelphia, Ohio (A)
103. Paisley Products Inc., Div. of Morningstar Nicol Inc., 630 W. 51st St., New York 19, N.Y. (A)
104. Pennsylvania Industrial Chemical Corp., Clairton, Pa. (R)
105. Perkins Glue Co., Lansdale, Pa. (RA)
106. Philadelphia Quartz Co., Philadelphia 6, Pa. (RA)
107. Pierce and Stevens, Inc., 710 Ohio St., Buffalo 3, N.Y. (A)
108. Pittsburgh Plate Glass Co., Paint Div., Pittsburgh, Pa. (R)
109. Plastics Engineering Co., Sheboygan, Wis. (R)
110. Plastite Adhesives Corp., Chicago 10, Ill. (RA)
111. Poly Resins, Sun Valley, Calif. (R)
112. Polymer Chemical Co., Cincinnati 12, Ohio (A)
113. Polymer Corp. of Pa., 2140 Fairmont Ave., Reading, Pa. (A)
114. Polymer Industries Inc., Springdale, Conn. (A)
115. Polypenco, Inc., Reading, Pa. (A)
116. Pyroxylin Products, Inc., Chicago 32, Ill.; Paoli, Pa. (A)
117. Raffi and Swanson, Inc., Wilmington, Mass. (A)
118. Reichhold Chemicals, Inc., White Plains, N.Y. (RA)
119. Ren Plastics Inc., Lansing 4, Mich. (A)
120. Reynolds Chemical Products Co., Ann Arbor, Mich. (A)
121. Rohm & Haas Co., Resinous Products Div., 222 W. Washington Sq., Philadelphia 5, Pa. (RA)
122. Rubba, Inc., 1015 E. 173rd St., New York 60, N.Y. (A)
123. Rubber and Asbestos Corp., Bloomfield, N.J. (A)
124. Rubber Corp. of America, Latex and Chemical Div., New South Road, Hicksville, Long Island, N.Y. (A)
125. Schenectady Varnish Co., Inc., Schenectady 1, N.Y. (R)
126. Schwartz Chemical Co., Inc., New York 23, N.Y. (A)
127. Shawinigan Products Corp., New York 1, N.Y. (RA)
128. Shell Chemical Corp., New York 17, N.Y. (RA)
129. Slomons Laboratories, Inc., Long Island City 1, N.Y. (A)
130. Stein-Hall and Co., Inc., New York 17, N.Y. (A)
131. Swift and Co., 4115 Packers Ave., Chicago 9, Ill. (A)
132. Synco Resins, Inc., Bethel, Conn. (RA)
133. Synvar Corp., 415 E. Front St., Wilmington 99, Del. (RA)
134. Tennessee Eastman Co., Kingsport, Tenn. (R)
135. UBS Chemical Corp., Cambridge 42, Mass. (A)
136. Union Paste Co., 1605 Hyde Park Ave., Hyde Park 36, Mass. (A)
137. U.S. Plywood Corp., 55 W. 44th St., New York 18, N.Y. (RA)
138. U.S. Rubber Co., Rockefeller Center, New York 20, N.Y. (RA)
139. U.S. Stoneware Co., 100 Brimfield Rd., Akron 9, Ohio (A)
140. Valite Corp., 726 Whitney Bldg., New Orleans 12, La. (RA)
141. Varcum Chemical Corp., Packard Rd., Niagara Falls, N.Y. (RA)
142. Velsicol Chemical Corp., Chicago 11, Ill. (R)
143. Watson-Standard Co., 225 Galveston Ave., Pittsburgh 30, Pa. (R)
144. Williamson Adhesives, Inc., 8220 Kimball Ave., Skokie, Ill. (A)
145. Wilross Products Co., 20 Fourth Ave., Hawthorne, N.J. (A)
146. Xylos Rubber Co., Div. of The Firestone Tire and Rubber Co., Akron 1, Ohio (A)
147. Wm. Zinsser and Co., Inc., New York 19, N.Y. (A)

*This list includes sources of bonding materials for compounding adhesives, indicated by (R), and sources of adhesive compositions prepared from the bonding materials, indicated by (A). The adhesives described on this chart are those formulated primarily with one type of plastic base. Many commercial adhesives are made up of complex mixtures of different resins in order to attain a combination of properties not found in a single type of base. The manufacturers of adhesives should be consulted before making a choice of material.

Coatings Chart

TYPE OF PLASTIC BASE	TRADE DESIGNATIONS OF RESINS OR COATINGS	MANUFACTURERS OR SUPPLIERS OF RESINS OR COATINGS (See list on pp. 578-9 for key to numbers)
1. Acrylate and methacrylate resins	Acrylac (170), Acryloid (156), Acrylon (27), Arcco (27), AT (160), Bedacryl (93), Cordobond (46), Corrocote (38), Coverlac (169), Dennis (50), Farrington (66), Gordon-Lacey (84), Hycryl (178), Inceloid (12), Kotol (124), Krylon (103), Logo (107), Lucite (57), MCW (114), Midland (113), Nopco (128), Nubeloid (80), Placco (27, 49), Placquer (49), Polyco (27), Polyflex (95), Polyplex (172), Reslac (27), Resyn (123), Rez-N-Lac (160), Rhoplex (156), Stanley (171), Ubatol (178), Wilross (187), 3 M (115)	4, 12, 17, 18, 27, 31, 38, 40, 46, 49, 50, 57, 66, 80, 84, 93, 95, 96, 98, 103, 107, 113, 114, 115, 123, 124, 128, 139, 143, 147, 148, 150, 156, 157, 160, 169, 170, 171, 172, 173, 176, 178, 183, 187
2. Alkyd resins (phthalic anhydride-polyhydric alcohol-oil combinations)	Alkydol (3), Amberlac (156), Armorcord (16), Aulflex (95), Bar-ox (177), Beckosol (151), Carbosol (132), Cellolyn (89), Crown (48), Duraplex (156), Durez (58), Dyal (166), Epok (30), Falkyd (34), FCD (71), Glyptal (77), Kotol (124), Logo (107), MCW (114), Mirasol (132), Oxalkyd (186), Paralac (93), Paraplex (156), Plaskon (22), Rez-N-Lac (160), Rezyl (8), Schenectady (159), Stanley (171), Sulivar (172), Syntex (99), Varkyd (111), Walkyd (151), Wilross (187)	3, 8, 16, 17, 18, 22, 28, 30, 31, 34, 44, 48, 58, 61, 71, 77, 80, 89, 93, 95, 98, 99, 107, 111, 114, 124, 132, 139, 148, 151, 156, 159, 160, 166, 170, 171, 172, 176, 177, 183, 187, 189
3. Allyl starch resin	Amercoat (4)	4, 80, 139
4. Asphalts	Arcco (27), Atlastic (19), Lebec (105), Loven (108), Midland (113), Nebony (125), Pioneer (188), Placco (27), Resinex (88), Reslac (27), Transphalt (136), Witcote (188), 3 M (115)	12, 19, 27, 80, 88, 105, 108, 113, 115, 116, 136, 188
5. Cellulose acetate	Acetoplex (172), Arcco (27), CD (39), Cymel (8), Dyal (166), Farrington (66), Gordon-Lacey (84), Hercules (89), Inceloid (12), Logo (107), MCW (114), Midland (113), Placco (27), Reslac (27), Rez-N-Lac (160), Wilross (187)	7, 12, 17, 27, 37, 39, 40, 57, 59, 66, 80, 84, 89, 98, 107, 113, 114, 115, 118, 139, 143, 147, 148, 150, 160, 166, 170, 172, 174, 187
6. Cellulose acetate butyrate	Arcco (27), Butaflex (172), Gordon-Lacey (84), Half-Second Butyrate (59), Lebec (105), Logo (107), MCW (114), Midland (113), Placco (27), Plastrip (145), Reslac (27), Resyn (123), Rez-N-Lac (160), Seal-Peel (161), Stanley (171), Thermo-Cote (25), Tool-Dip (142), Westcoat (184), Wilross (187)	17, 18, 25, 27, 40, 59, 65, 80, 84, 95, 98, 105, 107, 113, 114, 123, 139, 142, 143, 145, 147, 148, 150, 160, 161, 170, 171, 172, 174, 184, 187
7. Cellulose, carboxymethyl	Carbose (190), Cellofas (93), Hercules CMC (89), Logo (107), Midland (113), Sodium CMC (57)	31, 57, 89, 93, 107, 113, 139, 143, 160, 190
8. Cellulose, ethyl	Ethocel (54), Farrington (66), Gordon-Lacey (84), Hercules (89), Inceloid (12), Logo (107), MCW (114), Midland (113), Resyn (123), Rez-N-Lac (160), Thermo-Cote (25), Tool-Dip (142), Westcoat (184), Wilross (187)	12, 17, 18, 25, 40, 54, 66, 80, 84, 89, 95, 107, 113, 114, 123, 139, 142, 143, 147, 148, 160, 184, 187
9. Cellulose, hydroxyethyl	Cellosize (32), Logo (107), Midland (113), Whirlsint (122, 144)	32, 40, 107, 113, 139, 143
10. Cellulose, ethyl hydroxyethyl	EHEC (89), Midland (113)	89, 113, 160
11. Cellulose, methyl	Methocel (54)	54
12. Cellulose nitrate	Arcco (27), Armolac (16), Aultone (95), Blue Knight (95), CD (39), Dennis (50), Farrington (66), Hercules (89), Inceloid (12), Logo (107), MCW (114), Midland (113), Nik-o-lac (127), Placco (27), Reslac (27), Resyn (123), Rexlance (154), Rez-N-Lac (160), Stanley (171), Wilross (187)	8, 12, 16, 17, 18, 27, 28, 39, 40, 50, 57, 60, 80, 89, 95, 98, 107, 113, 114, 118, 123, 127, 139, 143, 147, 148, 150, 154, 160, 170, 171, 174, 176, 187
13. Cellulose propionate	Logo (107)	36, 107, 160
14. Chlorinated paraffins	Cereclor (93), Chlorowax (53), Clorafin (89), Halowax (21), Logo (107), Midland (113), Stan-Chlor Oil (88), Wilross (187)	21, 31, 53, 80, 88, 89, 91, 93, 107, 113, 139, 143
15. Chlorinated rubber	Alloprene (93), Apco (2), Arcco (27), Armorcote (16), Carboline (33), Corrocote (38), Dennis (50), Farrington (66), Gordon-Lacey (84), Laco (104), Lebec (105), Logo (107), MCW (114), Midland (113), Para-Stonetex (177), Paratex (177), Parlon (89), Placco (27), Resimene (118), Reslac (27), Rexadur (154), Rez-N-Lac (160), Roxaprene (95), Stanley (171), Texkote (142), Vulcabond (10), Wilross (187), Zerok (19), 3 M (115)	2, 9, 10, 16, 19, 27, 31, 33, 38, 50, 66, 80, 84, 89, 93, 95, 104, 105, 107, 113, 114, 115, 118, 139, 142, 143, 147, 154, 160, 170, 171, 176, 177, 178, 187
16. Coumarone resins	Cumar (22), Durez (58), Epok (30), Inceloid (12), Neville R (125), Nevindene (125), Nuba (125), Paradene (125), Piccoumaron (136), Piccovar (136), Wilross (187)	12, 22, 30, 58, 80, 85, 88, 125, 136, 139, 143, 147, 181, 187
17. Cyclized rubber	Acidseal (82), Alpex (3), Pliolite NR (83)	80, 82, 83, 139, 143, 147
18. Epoxy resins (epichlorohydrin bisphenol resins)	Alfane (19), Alk-o-flex (3), Amercoat (4), Amphesive (19), Araldite (41), Aritemp (15), Armorcoid (16), Bakelite (21), Beckosol (151), Carboline (33), Cardolite (97), CD (39), Chem-Fast (177), Devran (51), Duro-Lok (123), Dyphenite (166), Epi-Kote (74), Epiphen (27), Epi-Rez (99), Epi-Tex (99), Epi-Var (99), Epocast (60, 74), Epok (30), Epolac (104), Epon (165), Eponite (172), Epoxine (95), Epoxylite (64), Flawmaster (24), Helix (24), Hi-Bake Sterilkote (28), Hysol (92), Lithgow (106), Logo (107), Loven (108), Maraset (109), MCW (114), Midland (113), Mirasol (132), Napon (19), Nepoxide (19), Nipoxin (95), Nu-Pon (80), Nureco (130), Perma-Skin (50), Poly-Kast (142), Polyox (151), Ren (152), Resiweld (72), Rez-N-Lac (160), Schenectady (159), Sock-O-Plastic, (168), Speedrex (177), Stanley (171), Wilross (187), 3 M (115)	4, 14, 15, 16, 18, 19, 21, 24, 27, 28, 30, 33, 38, 39, 40, 41, 44, 50, 51, 60, 61, 64, 72, 74, 80, 92, 95, 97, 98, 99, 104, 106, 107, 108, 109, 113, 114, 115, 122, 123, 130, 132, 139, 142, 144, 147, 148, 150, 151, 152, 156, 159, 160, 165, 166, 168, 170, 171, 172, 176, 177, 183, 187
19. "Ester-type" resins-oil reactive (bicyclo-heptane dicarboxylic acid, and related esters with drying oils)	Stanley (171)	80, 139, 160, 171, 183
20. Ethylene resins (polyethylene)	A-C (162), Agilene (5), Alathon (57), Bakelite (21), Dow (54), Dylan (102), Epolene (59), Fedco (67), Fortiflex (36), Hi-fax (89), Ladcote (56), Logo (107), Marlex (138), Modulene (119), Resinite (153), Super Modulene (119), Whirlsint (122, 144)	5, 21, 37, 54, 56, 57, 59, 67, 80, 82, 87, 102, 107, 119, 122, 138, 139, 144, 147, 153, 162

[a]Code for solvents: A = Alcohols; C = Chlorinated hydrocarbons; E = Esters; F = Furan; G = Glycols; H = Aromatic hydrocarbons; I = Aliphatic hydrocarbons; K = Ketones; N = Nitrohydrocarbons; W = Water emulsions; WA = Aqueous alkali.

DRYING CLASSIFICATION[b]	SOLVENTS OR DISPERSING AGENTS[a]	RESISTANCE RATING[c]							SUITABILITY FOR USE IN COATING[c]										TYPICAL USES OF COATINGS MADE FROM PLASTIC BASE INDICATED ON OPPOSITE PAGE
		Acids	*Alkalies*	*Water*	*Solvents*	*Heat*	*Cold*	*Fungus*	*Weather*	*Metal*	*Paper*	*Fabrics*	*Plastics*	*Wood*	*Leather*	*Ceramics*	*Glass*	*Concrete*	*Wire*	
1. A, B, F	C, E, H, K, W	G*	G	E	P	E	M	G	E	G*	G	G	G	G	G	G	F	G	P	Electrical coatings, fabric treatment, leather finishing, metal and paper coatings, thickening and dispersing media
		*Poor to concentrated acids								*n-butyl, i-butyl and mixtures										
2. A, B, F	H, I, W	M	F	G	G	G	G	M	E	E	G	E	G	E	E	G	G	P	G	Automotive finishes, collapsible tube coatings, electrical insulation, emulsion paints, floor coverings, interior and exterior enamels, household and industrial coatings, metal decorative finishes, printing ink, rubber, water paints
3. A, B, F	A, C, E, H, K, N, W	M	M	M	E	G	G	–	–	G	G	G	–	E	–	G	G	–	–	Overprint varnishes, wood sealer
4. A, B, F	C, H, I	E	E	G	P	F	F	G	E	E	E	–	–	E	–	E	–	E	G	Packaging, pipe coatings, roofing, sealers, sound deadeners, undercoatings for autos
5. A, F	C, E, K, N, W	F	F	F	M	M	M	G	M	P	G	M	P	F	F	F	F	P	G	High gloss paper, oil- and grease-resistant papers, wire and wood coatings
6. A, F	A, C, E, H, K, N	F	F	M	F	M	G	G	G	G	G	M	G	F	F	F	P	P	G	Airplane dope, strippable coatings, gel lacquer, cable lacquer, finishes for paper, wood, and metal
7. A, F	W	F	P	P	E	G	G	M	F	–	G	E	G	–	G	–	P	G	–	Fabric finishing, warp sizing, grease-proofing, thickener
8. A, B, F	A, C, E, F, H, K, N	M	E	G	F	G	E	E	M	G	E	G	E	M	E	M	M	G	E	Masking agent, metal strip coating, sizing, packaging, styrene plastics, rubber
9. A, F	C, H, W	M	M	P	E	G	G	M	F	–	E	E	G	–	G	G	–	–	–	Color binding agent on fabrics, emulsion stabilizer in latex paints, fabric finishing, warp sizing
10. –	W	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Silk screen inks
11. A, F	W	F	P	P	G	G	G	P	–	–	G	E	G	–	E	G	–	G	–	Grease-proofing, thickener
12. A, F	A, E, K, N	G	F	E	F	P	G	G	M	E	E	E	–	E	E	–	–	F	–	Artificial leather, furniture coating, decorative coatings, floor finishes, auto and aircraft finishes, nail polish
13. A, F	A, C, E, H, K, N	F	F	M	F	M	G	G	G	M	G	M	F	G	P	F	M	P	G	Strippable coatings, gel lacquers, glass coatings
14. A, B, F	C, E, F, H, I, K, N	E	G	F	G	F	G	E	M	E	G	E	E	G	M	F	M	G	G	Flameproofing of textiles, paints, printing inks
15. A, B, F	C, E, H, K	E	E	E	F	F	G	E	G	E	E	G	–	G	–	–	–	E	–	Flame retardant coating, corrosion-resistant metal coatings, inks, soap wrap coatings, traffic paints
16. A, B, F	C, E, H, I, K	E	E	E	P	M	P	G	M	E	G	G	M	E	G	F	F	E	G	Anti-corrosive finishes, bronzing liquids, concrete coatings, marine finishes, printing inks, rubber compounds, pipe coatings, floor and trim varnishes, waterproof coatings, emulsion paints
17. A, B, F	C, H, I	E	E	E	G	M	G	E	E	G	E	–	–	–	–	–	–	E	–	Concrete enamel, corrosion-resistant paint, inks
18. A, B, F	A, E, G, H, I, K	E	E	E	E	G	E	E	E	E	G	–	G	E	M	E	E	G	G	Can coatings, corrosion-resistant maintenance coatings, chemical resistant coatings, electrical insulation, product finishes, drum linings, floor varnishes, marine finishes, inks, appliance primers, architectural paints and enamels
19. A, B, F	A, C, E, G, H, I, K, N	F	P	G	G	G	G	–	G	E	E	G	G	E	E	G	G	P	G	Durable paper for packaging, electrical insulation, ethyl cellulose lacquers, overprint, shade cloth
20. A, B, F	C, H, I, W (> 60 °C.)	E	E	E	E	G*	E	E	G*	G	E	E	G	P	–	–	–	E	E	Electrical insulation, drum linings, packaging of food, chemicals, and consumer products, hot melt coatings
		*With stabilizer																		

[b]Code for drying classification: A = Air drying; B = Baking; F = Force drying 120–150 °F.
[c]Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor

TYPE OF PLASTIC BASE	TRADE DESIGNATIONS OF RESINS OR COATINGS	MANUFACTURERS OR SUPPLIERS OF RESINS OR COATINGS *(See list on pp. 578-9 for key to numbers)*
21. Fluoroethylene resins	Agifluor (5), Bakelite (21), Corrocote (38), Exon (68), Fluron (179), Kel-F (100), Pee Vee Seal (19), Polyfluoron (1), Teflon (57)	1, 5, 21, 38, 57, 68, 80, 100, 179
22. Furan resins	Alkaloy (19), Aikor (19), Carboline (33), Duralon (179), Durez (58), Dyphene (166), Furatone (97), Furnane (19), Griffin (86), Jet-Kote (74), Lithgow (106), Loven (108), Resin X (74), Resistojet (74), Super-Beckacite (151), Tybon (26)	19, 26, 33, 58, 74, 80, 86, 97, 106, 108, 151, 166, 179
23. Hydrocarbon resins (derived from petroleum)	Arcco (27), Amercoat (4), Atlastic (19), JC (19), Loven (108), Midland (113), Nebony (125), Neville (125), Panarez (13), Piccopale (136), Piacco (27), Reslac (27), Velsicol (181), Wilross (187), 3 M (115)	4, 13, 19, 27, 28, 80, 88, 108, 113, 115, 125, 136, 139, 143, 181, 187
24. Isobutylene resins (polyisobutylene)	Logo (107), Oppanol B (129), Vistanex (63), Wilross (187)	56, 63, 80, 107, 129, 139, 143, 181, 187
25. Ketone resins	Bakelite (21), Corrocote (38)	21, 38, 40, 80, 139
26. Maleic resins	Amberol (156), Arcco (27), Beckacite (151), Carbasol (132), Cellolyn (89), Crown (48), Durez (58), Dyal (166), Dymal (166), Epok (30), FCD (71), Falkote (34), Lewisol (89), Mirasol (132), Pentalyn (89), Petrex (89), Piacco (27), Plaskon (22), Reslac (27), Rexatherm (154), Schenectady (159), Stanley (171), Synaryl (3), Syntex (99), Synvar V (173), Teglac (8), Wilross (187)	3, 8, 22, 30, 34, 40, 44, 48, 57, 58, 71, 76, 80, 89, 94, 95, 99, 132, 139, 147, 150, 151, 154, 156, 159, 166, 171, 172, 173, 183, 187
27. Melamine resins	Dymal (166), Epok (30), Logo (107), Plaskon (22), Polymerin (95), Resimene (118), Stanley (171), Super-Beckamine (151), Synvarol (173), Uformite (156), Wilross (187)	8, 22, 30, 40, 61, 80, 95, 107, 118, 139, 147, 151, 156, 159, 166, 171, 173, 183, 187
28. Natural resins (batu, congo, copal, damar, elemi, kauri, manila, Sandarac, etc.)	Innes (38), Kopol (151), Schenectady (159), Stanley (171), Wilross (187)	71, 80, 94, 147, 151, 159, 171, 183, 187
29. Oleo-resinous materials (combinations of oils, and natural and synthetic resins)	Alkydol (3), Amberlac (156), Armitage (16), Bakelite (21), Beckosol (151), Cellolyn (89), Crown (48), Duraplex (156), Durez (58), Dyal (166), Falkyd (34), GE (77), Ledwax (56), Lithgow (106), Miravar (132), Plaskon (22), Resimene (118), Rezyl (8), Schenectady (159), Stanley (171), Sullvar (172), Syntex (99), Synvaren (173), Wilross (187)	3, 8, 16, 21, 22, 27, 28, 34, 44, 48, 56, 58, 71, 77, 80, 89, 94, 95, 96, 99, 101, 106, 118, 126, 132, 139, 140, 150, 151, 156, 159, 166, 170, 171, 172, 173, 176, 183, 187
30. Phenol-formaldehyde modified and drying oil combinations (including paraphenylphenol-formaldehyde resins and alkylated phenol resins)	Acikote (179), Alkydol (3), Amberol (156), Armitage (16), Bakelite (21), Beckacite (151), Beckopol (151), Bedesol (93), Cardolite (97), Crown (48), Durez (58), Dyphenite (166), Epok (30), FCD (71), GE (77), Heresite (90), Hydrophen (151), Korez (19), Lamophene (142), Lebec (105), Logo (107), Loven (108), Methylon (77), McCloskey (111), Nevillac (125), Nobeilac (151), Pentalyn (89), Plaskon (22), Plastilock (82), Schenectady (159), Stanley (171), Sullvar (172), Synaryl (3), Syntex (99), Synvarite (173), Varcum (180), Wilross (187)	3, 16, 19, 21, 22, 28, 30, 31, 44, 48, 58, 71, 77, 80, 82, 89, 90, 93, 95, 97, 98, 99, 105, 107, 108, 111, 121, 125, 139, 142, 151, 156, 159, 160, 166, 171, 172, 173, 176, 179, 180, 183, 187, 189
31. Phenol-formaldehyde pure resins (spirit-soluble, "heat-reactive" types)	Amberol (156), Amercoat (4), Bakelite (21), Bedesol (93), Carbasol (132), Carboline (33), Cosmalite (42), Durez (58), Durite (27), Dyphene (166), Epok (30), FCD (71), GE (77), Heresite (90), Kaston (142), Kotol (124), Lebec (105), Lithgow (106), Logo (107), Loven (108), Marblette (109), Methylon (77), Mirasol (132), Nobellon (151), Plaskon (22), Plenco (141), Plyophen (151), P.Q.L. (124), Resinox (118), Schenectady (159), Sock-O-Plastic (168), Stanley (171), Super-Beckacite (151), Synvarite (173), Varcum (180), Wilross (187)	1, 4, 21, 22, 27, 28, 30, 31, 33, 40, 42, 44, 58, 71, 77, 80, 90, 93, 95, 98, 105, 106, 107, 108, 109, 118, 124, 132, 139, 141, 142, 151, 156, 159, 160, 166, 168, 171, 173, 176, 180, 183, 187
32. Polyamide resins	Agilon (5), Arcco (27), BCI (23), Corrocote (38), Gordon-Lacey (84), Lithgow (106), Logo (107), Piacco (27), Reslac (27), Versamid (78), Whirlsint (122,144), Wilross (187)	5, 23, 27, 28, 38, 40, 57, 78, 80, 84, 87, 107, 122, 139, 144, 147, 183, 187
33. Polyamide-epoxy resins	Amercoat (43), Corrocote (38), Dennis (50), Duro-Lok (123), Epolac (104), Logo (107), MCW (114), Nureco (130), Stanley (171), Vulcabond (10), Wilross (187), 3 M (115)	4, 10, 14, 27, 28, 38, 50, 78, 104, 107, 114, 115, 130, 150, 160, 171, 187
34. Polyester resins	Alkydol (3), Ampreg (19), Atlac (20), Carboline (33), Cellobond (30), FCD (71), Daltolac (31), GE (77), Glidpol (80), Goodrich, B.F. (82), Hetron (91), IC (95), Isolite (159), Laminal (8), Logo (107), Loven (108), Marco (36), MCW (114), Nureco (130), Paraplex (156), Plaskon (22), Plastaloy (19), Polylite (151), Schenectady (159), Selectron (140), Vibrin (124)	6, 8, 20, 22, 27, 30, 31, 33, 36, 38, 46, 71, 77, 80, 82, 91, 93, 95, 107, 108, 114, 124, 130, 139, 151, 156, 159, 176, 183
— Polyethylene (see 20)		
35. Polyethylene glycols	Carbowax (32)	32
35a. Polysulfide-epoxy	Epoxylite (64), Nureco (130), Rez-Cote (19)	19, 35, 45, 46, 64, 73, 75, 114, 175
36. Rubbers, synthetic a. Polychloroprenes b. Butadiene-styrene c. Butadiene-styrene trile d. Isoprene-isobutylene e. Isoprene-styrene f. Polysulfide g. Polyacrylic h. Polybutadiene — Polyisobutylene (see 24)	Acrylon (27), Ameran (82), Apco (2), Arcco (27), Baytex (178), Butaprene (69), Butarez (138), Carboline (33), Chemigum (83), Compo (43), Corrocote (38), Dennis (50), Elprene (19), Geo-Flo (79), Goodrich, B.F. (82), Griptex (2), Herecrol (90), Hycar (81), Kralastic (124), Laco (104), Logo (107), Lotol (124), Loven (108), Marbon (110), Midland (113), Naugapol (124), Naugatex (124), Neelium (13), Neobon (19), Neoprene (57), Nitrex (124), Nu-Fab (2), Paracril (124), Piacco (27), Plioflex (83), Polyco (27), Rand (149), Reslac (3), Rhoplex (156), Sock-O-Plastic (168), Spraylat (169), Thiokol (175), Thioment (19), Vulcabond (10), Wilross (187), 3 M (115)	a. 2, 14, 19, 27, 33, 38, 43, 50, 57, 70, 80, 82, 104, 107, 108, 113, 115, 121, 139, 143, 168, 178 b. 10, 12, 14, 27, 28, 38, 43, 50, 60, 69, 79, 80, 81, 82, 83, 90, 104, 107, 110, 113, 115, 124, 139, 143, 147, 149, 156, 157, 158, 169, 178, 187 c. (same as b.) d. 27, 80, 107, 139, 143 e. 80, 107, 139, 143 f. 19, 27, 33, 80, 82, 107, 108, 115, 143, 175 g. 27, 80, 81, 139, 143, 178 h. 107, 138
37. Shellac	Crown (48), Midland (113)	14, 48, 80, 113, 139, 147, 191
38. Silicone resins	Amercoat (4), Corrocote (38), DC Silicone Resins (55), G-E Silicone (77), Gordon-Lacey (84), Nubelon (80), Polytherm (95), Stanley (171), Super-Por-Seal (177), Union Carbide (167), Wilross (187)	4, 18, 38, 55, 77, 80, 84, 95, 139, 147, 167, 171, 176, 177, 183, 187

[a] Code for solvents: A = Alcohols; C = Chlorinated hydrocarbons; E = Esters; F = Furan; G = Glycols; H = Aromatic hydrocarbons; I = Aliphatic hydrocarbons; K = Ketones; N = Nitrohydrocarbons; W = Water emulsions; WA = Aqueous alkali.

DRYING CLASSIFICATION[b]	SOLVENTS OR DISPERSING AGENTS[a]	RESISTANCE RATING[c]							SUITABILITY FOR USE IN COATING[c]										TYPICAL USES OF COATINGS MADE FROM PLASTIC BASE INDICATED ON OPPOSITE PAGE
		Acids	Alkalies	Water	Solvents	Heat	Cold	Fungus	Weather	Metal	Paper	Fabrics	Plastics	Wood	Leather	Ceramics	Glass	Concrete	Wire	
21. B	C, W	E	E	E	E	E	E	E	–	E	G	–	–	–	–	E	E	–	E	Drum and tank linings, wire coatings, electrical and corrosion-resistant coatings
22. A, B, F	C, E, H, K	E	E	E	E	E	E	G	E	P	E	M	E	E	M	E	M	E	P	Coatings for wood, concrete, and metal tanks
23. A, B, F	C, E, H, I, N, W	E	E	E	P	M	F	G	M	E	G	G	G	E	G	F	F	E	G	Air-dry and baking enamels, anti-corrosive finishes, bronzing liquids, concrete coatings, floor and trim varnishes, marine finishes, pipe coatings, waterproof coatings
24. –	–	M	F	M	M	G	M	M	M	–	–	–	–	–	–	–	–	–	–	See waxes
25. A, B, C	A, E, F, G, H, I, K	G	E	F	M	G	G	G	–	–	–	–	–	–	–	–	–	–	–	Additive to improve adhesion of vinyl and phenolic coatings
26. A, B, F	C, E, H, I, K, N	M	F	M	M	G	M	M	M	G	G	F	F	E	M	F	P	F	F	Floor coverings, furniture lacquers, label coatings, oil cloth, printing inks, tin lithographing, interior enamels
27. B	A, H, I	E	E	G	G	G	G	G	E	E	G	G	G	G	P	E	G	–	G	Automotive coatings, can coatings, refrigerators, textile and leather finishing
28. A, B, F		F	F	G	M	M	G	E	F	E	E	–	–	E	G	–	–	G	E	Electrical insulation, floor coatings, lacquers, enamels, varnishes, furniture finishes
29. A, B, F	H, I	G	F	G	F	F	M	F	G	E	M	M	M	G	M	P	P	M	G	Can coating, cap liners, floor varnish, general household finishes, interior and exterior enamels, label coatings, oil cloth, rubbing and furniture varnish, spar varnish
30. A, B, F	A, E, H, I, K	G	F	E	G	G	G	M	G	E	G	G	E	E	G	E	E	G	E	Can and drum linings, coil varnish, furniture and interior enamels, insulating varnishes, spar, floor concrete, and exterior finishes, wood sealer
31. A, B, F	A, E, H, K, N	E	F	E	E	E	E	E	E	E	E	G	G	G	P	E	G	P	G	Beer cans and drum linings, food cans, food drying equipment, furniture, linings for chemical processing equipment, pipe coatings, rigid structural parts, tank car linings, product finishes
32. A, B, F	Alcohols ($>C_2$)	M	E	G	G	M	G	E	–	E	E	G	G	E	G	G	G	–	M	Heat sealing foil, labels, packaging papers, printing inks, wire, fabric and paper coating, thixotropic paints
33. A, B, F	A, H, I, K, W	G	E	E	G	G	E	E	–	E	E	G	E	E	G	E	E	E	E	Can coatings, wire insulation, marine finishes, anti-corrosive finishes, drum linings, pipe linings, chemical resistant coatings
34. B, F	H	G	F	G	G	G	G	M	E	E	–	–	–	–	–	–	–	–	E	Electrical insulation, potting compound, concrete, cinder-block, and brick enamels, wood finishing
35. A, F	C, H, W	P	P	P	E	F	F	G	–	F	E	E	E	–	–	P	G	–	F	Anti-fogging coatings for glass, fabric sizing and finishing, paper lubricant, wire drawing
35a. A, B, F	H, K, N	G	E	G	E	G	G	G	–	E	E	E	E	E	E	E	E	E	E	Coatings for metal, concrete, wood, and marine surfaces; wire insulation
35.																				
a. A, B, F	C, E, H, K, W	E	E	E	E	E	E	E	E	E	E	E	G	G	E	G	G	E	E	Concrete paint, electrical insulation and jackets, emulsion paints, floor covering, leather finish, linings for chemical equipment, paper coatings, protective coatings for pipes, valves, tanks, plating racks, wire products, fans, pumps, and electroplating equipment
b. A, B, F	C, E, H, K, N, W	E	E	E	F	G	E	G	E	E	G	G	G	G	–	G	–	G	E	
c. A, B, F	C, H, K, W	E	E	E	G	E	E	E	E	G	E	E	G	G	E	G	–	G	E	
d. A, B, F	C, H, I	G	E	E	G	E	G	G	G	–	–	E	–	–	–	–	–	–	E	
e. A, B, F	C, E, H, I, K, N	E	E	E	F	F	E	G	E	G	G	P	E	F	E	E	E	G		
f. A	C, H, K, W	F	G	G	E	M	G	–	G	G	G	G	–	G	G	–	–	G	–	
g. —	C, E, H, K	F	F	F	G	E	F	G	E	G	E	E	–	E	E	–	–	–	E	
h. A, B	—	–	–	–	E	E	–	–	–	–	–	–	–	–	–	–	–	–	–	Modifying agent for drying oils
37. A	A	F	F	M	F	M	G	E	F	E	E	E	E	E	E	E	E	E	E	Electrical insulation, floor varnish, leather dressings, wood sealer
38. A, B	C, E, H, I, K	G	G	E	F	E	E	E	E	E	–	G	P	–	–	E	E	G	G	Electrical insulation, heat resistant coatings, waterproof treatments, glass sizing for laminating

[b] Code for drying classification: A = Air drying; B = Baking; F = Force drying 120-150° F.
[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor.

TYPE OF PLASTIC BASE	TRADE DESIGNATIONS OF RESINS OR COATINGS	MANUFACTURERS OR SUPPLIERS OF RESINS OR COATINGS (See list on pp. 578-9 for key to numbers)
39. Silicone-alkyd resins	Dow Corning (55), Dyal (166), FCD (71), Nubelon (80), Plaskon (22), Schenectady (159), Stanley (171), Syntex (99), Union Carbide (167), Vulcabond (10), Wilross (187)	10, 18, 22, 55, 71, 80, 99, 139, 159, 166, 167, 171, 183, 187
40. Silicone-phenolic	Dow Corning (55)	55, 80
41. Silicone rubber	GE (77), Silastic (55), Union Carbide (167)	55, 77, 167
42. Styrene resins (polystyrene)	Arcco (27), Bakelite (21), Calvoseal (106), CD (39), Dow Latex (54), Epok (30), Inceloid (12), KTPL (102), Ladcote (56), Loxite (69), Lustrex (118), Marbon (110), Midland (113), Nopco (128), Piccolastic (88,136), Placco (27), Plastiplex (172), Polyco (27), Polystyrolac (170), PS-Resin (54), Resgrip (2), Reslac (27), Rez-N-Lac (160), Stanley (171), Styroloid (170), Styrophane (170), Ubatol (178), Wallpol (151), Wilross (187)	2, 12, 17, 18, 21, 27, 30, 39, 54, 56, 69, 80, 83, 88, 102, 106, 107, 110, 113, 118, 128, 136, 139, 143, 147, 150, 151, 159, 160, 170, 171, 172, 176, 178, 187
43. Styrene-butadiene resins	Arcco (27), Butaprene (68), Carboline (33), Darex (52), Dow Latex (54), Gordon-Lacey (84), Kralastic (124), Laco (104), Lotol (124), Marbon (110), Midland (113), Placco (27), Pliolite (83), Plio-Tuf (83), Polyco (27), Polyplex (172), Reslac (27), Rez-N-Lac (160), Wilross (187), Zerok (19)	19, 27, 28, 33, 52, 54, 68, 80, 83, 84, 102, 104, 110, 113, 124, 139, 148, 160, 172, 176, 183, 187
44. Styrenated alkyd	Alkydol (3), Armorcord (16), Cycopol (8), Dennis (50), Dyal (166), FCD (71), Fosterite (185), MCW (114), Plaskon (22), Resimene (118), Schenectady (159), Stanley (171), Styresol (151), Styretex (99), Wilross (187)	3, 8, 16, 18, 22, 28, 40, 44, 50, 55, 71, 80, 95, 98, 99, 114, 139, 147, 148, 151, 159, 166, 170, 171, 172, 176, 183, 185, 187
45. Styrenated drying oils	Wilross (187)	3, 44, 80, 139, 187
46. Terpene resins	Indu-sealz (124), Marbon (110), Piccolyte (136), Schenectady (159), Wilross (187)	80, 88, 110, 124, 136, 139, 147, 159, 187
47. Terpene-phenolics	Crown (48), Durez (58), Schenectady (159), Super-Beckacite (151), Varcum (180), Wilross (187)	48, 58, 80, 151, 159, 180, 183, 187
48. Urea-formaldehyde resins and oil-resin combinations	Amerite (27), Arcco (27), Armorcoid (16), Beckamine (151), Beetle (8), Epok (30), Ful-O-Mite (72), Lebec (105), Loven (108), Midland (113), Paralac (93), Placco (27), Plaskon (22), Polymerin (95), Resimene (118), Reslac (27), Stanley (171), Syn-U-Tex (99), Synvarol (173), Uformite (156), Wilross (187)	8, 16, 22, 27, 28, 30, 31, 40, 72, 80, 93, 95, 98, 99, 105, 106, 108, 113, 118, 139, 147, 151, 156, 160, 170, 171, 173, 176, 187
49. Urethanes (polyurethanes)	Daltolac (93), Goodrich, B.F. (82), Isomelt (159), Mondur/Multron (117), Pelron (135), Suprasec (93)	31, 38, 82, 93, 117, 135, 148, 159
50. Vinyl acetate resins	Acetex (124), Ameran (82), Arcco (27), Bakelite (21), CD (39), Celanese (36), Corrocote (38), Crown (48), Darex (52), Dennis (50), Elvacet (57), Elvalon (57), Epok (30), Fuller (72), Gelva (164), Goodrich, B.F. (82), Gordon-Lacey (84), Griffco (86), Inceloid (12), Lemac (27), Midland (113), Nopco (128), Placco (27), Polyco (27), Poly-Tex (99), Reslac (27), Resyn (123), Stanley (171), Synvar VE (173), Vinac (42), Vinaplas-Lac (160), Vinymul (133), Wallpol (151), Wilross (187)	12, 14, 18, 21, 27, 28, 30, 36, 38, 39, 42, 46, 48, 50, 52, 57, 72, 80, 82, 84, 86, 98, 99, 106, 113, 123, 124, 128, 133, 139, 142, 143, 147, 148, 151, 160, 164, 170, 171, 173, 176, 187
51. Vinyl alcohol	Elvanol (57), Gelvatol (164), Lemol (27), Midland (113), Resyn (123), Vinol (42), 3 M (115)	27, 42, 46, 57, 113, 115, 123, 139, 143, 160, 164
52. Vinyl butyral resins	Amercoat (4), Arcco (27), Armorcote (16), Bakelite (21), Butacite (57), Butvar (164), Calvinac (106), Corogard (115), Dispersite (124), Goodrich, B.F. (82), Gordon-Lacey (84), MCW (114), Perma-Skin (50), Placco (27), Protectophene (142), Rand (149), Reslac (27), Spraylat (169), Stanley (171), Vy King (51), Wilross (187)	4, 16, 18, 21, 27, 28, 40, 50, 51, 57, 80, 82, 84, 106, 114, 115, 124, 139, 142, 143, 147, 149, 150, 160, 164, 169, 171, 176, 183, 187
53. Vinyl chloride resins	Ace-Flex (9), Ameran (82), Amercoat (4), Ampcoflex (19), Arcco (27), Armosol (16), Avaloid (98), Bakelite (21), Breon (29), Calvinac (106), CD (39), Chem-o-sol (40), Cordobond (46), Corrocote (38), Cyclon (120), Diamond PVC (53), Dow Latex (54), Elastosol (60), Epocast (60), Farrington (66), Firestone latex (68), Geon (81), Goodrich, B.F. (82), Gordon-Lacey (84), Inceloid (12), Kotol (124), Marvinol (124), Miccrosol (112), Midland (113), Opalon (118), Osco (131), Parcloid (134), Pee Vee Cee (19), Peel-Kote (120), Perma-Skin (50), Placco (27), Plastrip (145), Pliovic (83), Polyco (27), Polyprene (95), P-T-I (145), Rand (149), Resinite (153), Reslac (27), Resyn (123), Reynosol (155), Stanley (171), Sterilkote (28), Tool-Dip (142), Tygon (179), Vichrome (95), Vinaplas-Lac (160), Vinrex (154), Vygen (79), Vy King (99), Westoflex (184), Wilflex (70), Wilross (187)	9, 11, 12, 14, 16, 18, 21, 27, 28, 29, 38, 39, 40, 46, 50, 53, 54, 60, 61, 62, 65, 66, 68, 70, 79, 80, 81, 82, 83, 84, 95, 98, 99, 106, 112, 113, 118, 120, 123, 124, 131, 134, 139, 142, 143, 145, 147, 148, 149, 153, 154, 155, 157, 158, 160, 163, 170, 171, 176, 179, 183, 184, 187
54. Vinyl chloride-acetate resins (higher chloride types)	Airstrip (142), Ameran (82), Amercoat (4), Arcco (27), Armorhide (16), Bakelite (21), Breon (29), Carboline (33), CD (39), Cordobond (46), Corogard (115), Corrocote (38), Coverlac (169), Elastomer (60), Epocast (60), Exon (68), Gordon-Lacey (84), Inceloid (12), MCW (114), Midland (113), Nubelyn (80), Perma-Skin (50), Placco (27), Plastrip (145), Polyco (27), Rand (149), Reslac (27), Resyn (123), Reynosol (155), Sock-O-Plastic (168), Stanley (171), Tygon (179), Vinaplas-Lac (160), Vulcabond (10), Vy King (51), Wilross (187), Zerok (19)	4, 10, 12, 14, 16, 18, 19, 21, 27, 28, 29, 33, 38, 39, 40, 46, 50, 51, 60, 68, 70, 74, 80, 82, 84, 98, 106, 113, 114, 115, 123, 139, 142, 143, 145, 147, 149, 155, 160, 168, 169, 171, 176, 179, 183, 187
55. Vinyl chloride-vinylidene chloride copolymers	Ameran (82), Amercoat (4), Arcco (27), Breon (29), Carboline (33), Corogard (115), Corrocote (38), Geon (81), Goodrich, B.F. (82), Inceloid (12), Midland (113), Perma-Skin (50), Placco (27), Polyco (27), Rand (149), Reslac (27), Resyn (123), Saran (54), Vinaplas-Lac (160), Vinol (42), Wiflex (70), Wilross (187)	4, 12, 14, 27, 28, 29, 33, 38, 40, 42, 50, 54, 57, 70, 80, 81, 82, 98, 113, 123, 139, 143, 147, 149, 160, 176, 183, 187
56. Vinyl ether resin	Oppanol C (129), PVI (76), PVM (76), Wilross (187)	14, 76, 129, 187
57. Vinyl formal resins	Formvar (164), Schenectady (159)	80, 159, 160, 164
58. Vinyl pyrrolidone resin	PVP (76)	76

[a]Code for solvents: A = Alcohols; C = Chlorinated hydrocarbons; E = Esters; F = Furan; G = Glycols; H = Aromatic hydrocarbons; I = Aliphatic hydrocarbons; K = Ketones; N = Nitrohydrocarbons; W = Water emulsions; WA = Aqueous alkali.

DRYING CLASSIFICATION[b]	SOLVENTS OR DISPERSING AGENTS[a]	RESISTANCE RATING[c]							SUITABILITY FOR USE IN COATING[c]									TYPICAL USES OF COATINGS MADE FROM PLASTIC BASE INDICATED ON OPPOSITE PAGE
		Acids	*Alkalies*	*Water*	*Solvents*	*Heat*	*Cold*	*Fungus*	*Weather*	*Metal*	*Paper*	*Fabrics*	*Plastics*	*Wood*	*Leather*	*Ceramics*	*Glass*	*Concrete*	*Wire*	
39. A, B	E, H, K, I	E	G	E	G	E	E	–	E	E	E	E	E	E	E	E	E	–	G	Heat resistant coatings, chalk-resistant maintenance paints, alkali-resistant enamels
40. A, B	E, H, I, K	G	G	E	G	E	F	–	E	E	–	–	E	E	E	E	E	G	G	Weather and water resistant finishes, maintenance paints
41. B	C, H, I	G	M	E	P	E	E	E	E	G	–	E	–	–	–	E	E	–	G	Calking, coating asbestos paper, coating glass fabrics, gaskets
42. A, B, F	C, E, H, K, N, W	E	E	E	P	F	F	E	G	M	G	E	P	F	E	P	P	E	P	Adhesive sizing, concrete enamels, delustering, detackifier, electric insulation, finishing, stiffening, glass coating, label varnish, leather finish, solvent coating, rubber compounding, floor wax finishes
43. A, B, F	C, H, I, K, W	E	E	E	G	G	E	E	E	E	E	E	–	G	G	–	–	E	E	Concrete enamels, corrosion-resistant paints, interior-exterior latex paints, fabric coatings and sizings, paper coatings, rubber compounding
44. A, B, F	H, I	F	G	G	G	G	M	–	E	E	G	G	–	E	–	–	G	–	–	Decorative coatings, decorative over-finishes, electrical insulation, furniture, high gloss paper, toys
45. A, B, F	H, I	M	G	G	P	G	G	–	–	E	G	E	G	E	E	–	G	F	–	Interior and exterior paints
46. A	C, H, I, N, W	E	E	E	P	G	F	E	M	M	G	G	F	G	G	F	F	E	F	Hot melts, laminating, rubber compounding, sealing, waterproofing
47. A	C, E, H, I	M	G	E	F	G	G	E	–	E	–	G	E	E	G	–	–	G	E	Architectural finishes, exterior fabrics (canvas), floor covering, industrial finishes, metal furniture, printing inks
48. B, F	A, H	E	E	E	G	G	G	–	G	E	G	M	G	E	P	E	G	–	G	Automobiles, cap liners, collapsible tube coatings, furniture lacquers, kitchen and hospital equipment, refrigerators, textile finishing, venetian blinds
49. A, B, F	E, H, K	G	G	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	Anti-corrosive, solvent-resistant finishes, abrasion and impact resistant finishes, high dielectric coatings
50. A, F	A, C, E, F, H, K, N, W, WA	M	M	G	P	M	M	E	G	G	E	E	G	E	G	G	G	E	–	Decorative, fabric finishing, greaseproofing heat sealing, intaglio inks, leather finish, pigmented and gloss paper coatings, exterior and interior paints
51. A, F	W	P	P	P	E	G	G	G	F	E	E	E	–	–	E	M	–	–	–	Emulsifying, thickening, greaseproofing
52. A, B, F	A, E	M	G	G	M	G	E	G	G	E	–	E	–	E	–	–	E	–	–	Adhesives, foil packaging, impregnating, upholstery, anticorrosive primers, can linings, drum coatings, wood sealers, strip coatings
53. A, B, F	C, E, F, H, I, K, N, W	E	E	E	F	G	G	E	G	E	E	E	P	P	G	P	P	P	E	Concrete vats and piping, electrical insulation, fabric and paper coatings, food packaging, greaseproofing, lining plating baths, strippable coatings, anti-corrosive maintenance coatings, decorative coatings, drum linings, product finishes
54. A, B, F	F, H, K, N, W	E	E	E	F	G	G	E	G	E	E	E	P	P	E	P	P	E	E	Collapsible tube coatings, fabric and paper treatments, lining storage tanks, protection of steel against weathering and corrosion, strippable packaging, wire coating, automobile sealers, decorative coatings, drum linings, product finishes
55. A, B, F	C, E, F, H, K, W	E	E	E	E	E	G	E	G	G	E	E	E	G	E	–	–	G	G	Food packaging, greaseproofing paper, finishes, strippable packaging
56. A, B, F	A, C, E, H, K, N, W	P	P	P	P	F	G	G	G	G	G	G	G	G	G	G	G	G	–	Additive in chlorinated rubber paints
57. A, B, F	A, C, F, H, N	M	G	G	G	G	E	G	G	E	–	–	–	E	–	–	–	–	E	Wire coating, can linings, drum coatings, anti-corrosive primers
58. A, B, F	A, C, G, H, K, N, W	P	P	P	P	G	G	G	F	M	E	E	G	M	E	E	E	–	–	Dispersing and emulsifying agent, glass coatings, inks, leveling pigment

[b]Code for drying classification: A = Air drying; B = Baking; F = Force drying 120–150°F.
[c]Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor

TYPE OF PLASTIC BASE	TRADE DESIGNATIONS OF RESINS OR COATINGS	MANUFACTURERS OR SUPPLIERS OF RESINS OR COATINGS *(See list below for key to numbers)*
59. Vinylidene chloride—acrylonitrile resins	Arcco (27), Corogard (115), Goodrich, B.F. (82), Placco (27), Reslac (27), Resyn (123), Saran (54), Sock-O-Plastic (168), Vulcabond (10), Wilross (187)	9, 10, 19, 27, 54, 80, 82, 115, 123, 139, 147, 168, 187
60. Waxes (paraffin, microcrystalline, etc.)	Aristowax (137), Mekon (182), Multiwax (137), Reswax (27), Warco (182)	10, 14, 27, 57, 80, 116, 137, 147, 182
61. Zein (soluble protein)	Argo (47)	47

*Code for solvents: A = Alcohols; C = Chlorinated hydrocarbons; E = Esters; F = Furan; G = Glycols; H = Aromatic hydrocarbons; I = Aliphatic hydrocarbons; K = Ketones; N = Nitrohydrocarbons; W = Water emulsions; WA = Aqueous alkali.

LIST OF MANUFACTURERS AND SUPPLIERS OF COATINGS AND RESINS FOR COATINGS*

1. Acme Resin Corp., 1401 Circle Ave., Forest Park, Ill. (C)
2. Adhesive Products Corp., 1660 Boone Ave., New York 60, N. Y. (C)
3. Alkydol Laboratories, Inc., 3242 S. 50th Ave., Cicero 50, Ill. (R)
4. Amercoat Corp., 4809 Firestone Blvd., South Gate, Calif. (C)
5. American Agile Corp., P.O. Box 168, Bedford, Ohio (C)
6. American Alkyd Industries, Broad and 14th Sts., Carlstadt, N. J. (C)
7. American-British Chemical Supplies, Inc., 180 Madison Ave., New York 16, N.Y. (R)
8. American Cyanamid Co., 30 Rockefeller Plaza, N.Y. 20, N.Y. (R)
9. American Hard Rubber Co., New York 13, N.Y. (C)
10. American Latex Products Corp., Hawthorne, Calif. (C)
11. American Lucoflex Inc., 500 5th Ave., New York 36, N.Y. (C)
12. American Products Manufacturing Co., New Orleans, La. (C)
13. Amoco Chemicals Corp., Chicago 80, Ill. (R)
14. Angier Adhesives, Div. of Interchemical Corp., 120 Potter St., Cambridge 42, Mass. (C)
15. Aries Laboratories, Inc., 270 Park Ave., New York 17, N.Y. (C)
16. Armitage and Co., John L., 245 Thomas St., Newark 5, N.J. (C)
17. Arrow Lacquer Corp., 208 Dupont St., Brooklyn 22, N.Y. (C)
18. Atlas Coatings Corp., Long Island City 1, N.Y. (C)
19. Atlas Mineral Products Co., Mertztown, Pa. (C)
20. Atlas Powder Co., Wilmington 99, Del. (C)
21. Bakelite Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y. (R)
22. Barrett Div., Allied Chemical and Dye Corp., 40 Rector St., New York 6, N.Y. (R)
23. Belding Corticelli Industries, Chemicals Div., 1407 Broadway, New York 18, N.Y. (C)
24. Biggs Co., Inc., Carl H., Los Angeles 64, Calif. (C)
25. Bischoff Chemical Corp., Ivoryton, Conn. (C)
26. Booty Resineers, Inc., 112 Jefferson St., Newark, Ohio (C)
27. Borden Co., The, Chemical Div., 350 Madison Ave., New York 17, N.Y. (R)
28. Bradley and Vrooman Co., 2629 S. Dearborn St., Chicago 16, Ill. (C)
29. British Geon Ltd., London S.W. 1, England (R)
30. British Resin Products Ltd., London S.W. 1, England (R)
31. Canadian Industries Ltd., Montreal, Canada (R)
32. Carbide and Carbon Chemicals Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y. (R)
33. Carboline Co., 331 Thornton Ave., St. Louis 19, Mo. (C)
34. Cargill, Inc., Vegetable Oil Div., 200 Grain Exchange, Minneapolis 15, Minn. (RC)
35. Ceilcote Co., 4832 Ridge Road, Cleveland 9, Ohio (C)
36. Celanese Corp. of America, Plastics Div., 290 Ferry St., Newark 5, N.J. (RC)
37. Celanese Corp. of America, Textile Div., P.O. Box 1414, Charlotte, N.C. (R)
38. Chemical Coatings and Engineering Co., West Chester Pike, Edgemont, Pa. (C)
39. Chemical Development Corp., Danvers, Mass. (C)
40. Chemical Products Corp., E. Providence 14, R.I. (C)
41. Ciba Co., Inc., Plastics Div., Kimberton, Pa. (R)
42. Colton Chemical Co., 1747 Chester Ave., Cleveland 14, Ohio (R)
43. Compo Chemical Co., Inc., Boston 14, Mass. (C)
44. Cook Paint & Varnish Co., P.O. Box 389, Kansas City, Mo. (C)
45. Copolymer Chemicals, Inc., 12350 Merriman Road, Livonia, Mich. (C)
46. Cordo Chemical Inc., 34 Smith St., Norwalk, Conn. (C)
47. Corn Products Sales Co., New York 4, N.Y. (R)
48. Crownoil Chemical Co., Inc., Long Island City 1, N.Y. (R)
49. Custom Coatings Co., Los Angeles 34, Calif. (C)
50. Dennis Chemical Co., 2701 Papin St., St. Louis 3, Mo. (C)
51. Devoe & Raynolds Co., Inc., P.O. Box 328, Louisville 1, Ky. (C)
52. Dewey and Almy Chemical Co., Div. of W.R. Grace and Co., Cambridge 40, Mass. (R)
53. Diamond Alkali Co., Cleveland 14, Ohio (R)
54. Dow Chemical Co., The, Midland, Mich. (R)
55. Dow Corning Corp., Midland, Mich. (R)
56. L.A. Dreyfus Co., S. Plainfield, N.J. (C)
57. E.I. du Pont de Nemours and Co., Wilmington 98, Del. (RC)
58. Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N.Y. (R)
59. Eastman Chemical Products, Inc., Kingsport, Tenn. (R)
60. Elastomer Chemical Corp., 212 Wright St., Newark 5, N.J. (C)
61. Electro-Technical Products Div., Sun Chemical Corp., 113 E. Centre St., Nutley 10, N.J. (C)
62. Elm Coated Fabrics Co., 261 Fifth Ave., New York 16, N.Y. (C)
63. Enjay Co., Inc., 15 W. 51st St., New York 19, N.Y. (R)
64. Epoxylite Corp., 10829 E. Central Ave., El Monte, Calif. (C)
65. Eronel Industries, 12607 Cerise Ave., Hawthorne, Calif. (C)
66. Farrington Texol Corp., 2000 Main St., Walpole, Mass. (C)
67. Federal Chemicals Corp., Brooklyn 11, N.Y. (C)
68. Firestone Plastics Co., P.O. Box 690, Pottstown, Pa. (R)
69. Firestone Tire and Rubber Co., Akron, Ohio (R)
70. Flexible Products Co., P.O. Box 306, Marietta, Ga. (C)
71. France, Campbell and Darling, Inc., Kenilworth, N.J. (R)
72. Fuller Co., H.B., St. Paul 2, Minn. (C)
73. Fuller and Co., W.P., P.O. Box 3727, Los Angeles 54, Calif. (C)
74. Furane Plastics, Inc., 4516 Brazil St., Los Angeles, Calif. (RC)
75. Garland Co., 3800 E. 91st St., Cleveland, Ohio (C)
76. General Aniline and Film Corp., New York 14, N.Y. (R)
77. General Electric Co., 1 Plastics Ave., Pittsfield, Mass. (R)
78. General Mills, Inc., Chemical Div., P.O. Box 191, Kankakee, Ill. (RC)
79. General Tire and Rubber Co., The, Akron 9, Ohio (R)
80. Glidden Co., 11001 Madison Ave., Cleveland 2, Ohio (C)
81. B.F. Goodrich Chemical Co., Cleveland 15, Ohio (R)
82. B.F. Goodrich Co., Industrial Products Div., Akron 8, Ohio (C)
83. Goodyear Tire and Rubber Co., Inc., Chemical Div., Akron, O. (R)
84. Gordon-Lacey Chemical Products Co., 57-02 48th St., Maspeth 78, N.Y. (C)
85. Grand Rapids Varnish Corp., Grand Rapids 2, Mich. (C)
86. Griffin Chemical Co., Div. of Nopco Chemical Co., 1000 16th St., San Francisco 7, Calif. (C)
87. H & R Industries, 344 E. Walnut St., Nazareth, Pa. (C)
88. Harwick Standard Chemical Co., Akron 5, Ohio (R)
89. Hercules Powder Co., Wilmington 99, Del. (R)
90. Heresite and Chemical Co., 822 S. 14th St., Manitowoc, Wis. (C)
91. Hooker Electrochemical Co., Niagara Falls, N.Y. (R)
92. Houghton Laboratories, Inc., Olean, N.Y. (R)
93. Imperial Chemical Industries Ltd., London S.W. 1, England (R)
94. O.G. Innes Corp., 82 Wall St., New York 5, N.Y. (R)
95. Interchemical Corp., Finishes Div., 67 W. 44th St., N.Y., N.Y. (C)
96. Irvin, Jewell, and Vinson Co., 17 E. 3rd St., Dayton, Ohio (C)

*This chart includes information on sources of film-forming materials for compounding protective coatings, indicated by (R), and sources of protective coatings prepared from the film-forming materials, indicated by (C). Compounding usually involves the addition of water or organic solvents, plasticizers, colorants, defoamers, detackifiers, thickeners, antioxidants, stabilizers, etc.

DRYING CLASSIFICATION[b]	SOLVENTS OR DISPERSING AGENTS[a]	RESISTANCE RATING[c]								SUITABILITY FOR USE IN COATING[c]										TYPICAL USES OF COATINGS MADE FROM PLASTIC BASE INDICATED ON OPPOSITE PAGE
		Acids	*Alkalies*	*Water*	*Solvents*	*Heat*	*Cold*	*Fungus*	*Weather*	*Metal*	*Paper*	*Fabrics*	*Plastics*	*Wood*	*Leather*	*Ceramics*	*Glass*	*Concrete*	*Wire*	
59. F	K, W	E	M	E	E	P	F	E	E	M	E	G	P	P	F	P	P	F	M	Artificial leather, cap liner, chemical resistance, greaseproofing paper
60. —	H, I, N	E	E	E	–	–	F	G	–	G	E	E	G	G	M	M	G	E	F	Paper coatings for food packaging, beverage containers, cheese wrappers, collapsible tubes, laminated paper
61. A, F	A, C, G, W, WA	F	P	M	G	G	M	F	–	G	E	E	M	E	G	G	F	E	F	Cork binding, greaseproofing, pharmaceutical tablet coating

[b] Code for drying classification: A = Air drying; B = Baking; F = Force drying 120-150° F.
[c] Code for rating: E = Excellent; G = Good; M = Moderate; F = Fair; P = Poor

LIST OF MANUFACTURERS AND SUPPLIERS OF COATINGS AND RESINS FOR COATINGS* (*Cont.*)

97. Irvington Chemical Div., Minnesota Mining and Mfg. Co., 500 Doremus Ave., Newark 5, N.J. (C)
98. Jamestown Finishes Inc., Jamestown, N.Y. (C)
99. Jones-Dabney Co., 1481 S. 11th St., Louisville 8, Ky. (RC)
100. M.W. Kellogg Co., P.O. Box 469, Jersey City 3, N.J. (R)
101. Keystone Refining Co., Philadelphia 37, Pa. (C)
102. Koppers Co., Inc., Chemical Div., Pittsburgh 19, Pa. (R)
103. Krylon, Inc., Norristown, Pa. (C)
104. Lawrence Adhesives and Chemical Co., Lawrence, Mass. (C)
105. Lebec Chemical Corp., 14066 S. Garfield Ave., Paramount, Calif. (C)
106. Lithgow Chemicals Co., Div. of Reinhold Engineering and Plastics Co., 12827 E. Imperial Highway, Norwalk, Calif. (C)
107. Logo, Inc., Chicago 33, Ill. (C)
108. Loven Chemical of California, Newhall, Calif. (RC)
109. Marblette Corp., 37-21 30th St., Long Island City, N.Y. (R)
110. Marbon Chemical Div., Borg-Warner Corp., Gary, Ind. (R)
111. McCloskey Varnish Co., Philadelphia 36, Pa. (C)
112. Michigan Chrome and Chemical Co., Detroit 13, Mich. (C)
113. Midland Adhesive and Chemical Corp., Detroit 20, Mich. (C)
114. Midwestern Color Works, 3134 California St., N.E., Minneapolis 13, Minn. (C)
115. Minnesota Mining and Manufacturing Co., Detroit 2, Mich. (C)
116. Mitchell Rand Mfg. Corp., 51 Murray St., New York 7, N.Y. (C)
117. Mobay Chemical Co., St. Louis 4, Mo. (R)
118. Monsanto Chemical Co., Plastics Div., Springfield 2, Mass. (R)
119. Muehlstein, H., and Co., Inc., New York 17, N.Y. (R)
120. Munray Products, Inc., Cleveland 11, Ohio (C)
121. Narmco Resins and Coatings Co., 600 Victoria St., Costa Mesa, Calif. (C)
122. National Polymer Products, Inc., 125 N. Fourth St., Reading, Pa. (C)
123. National Starch Products, Inc., Resin Div., 270 Madison Ave., New York 16, N.Y. (RC)
124. Naugatuck Chemical Div., U.S. Rubber Co., Elm St., Naugatuck, Conn. (RC)
125. Neville Chemical Co., Pittsburgh 25, Pa. (R)
126. Newport Industries Co., Div. of Heyden Newport Chemical Corp., 342 Madison Ave., New York 17, N.Y. (R)
127. G.J. Nikolas and Co., Inc., Bellwood, Ill. (C)
128. Nopco Chemical Co., Inc., Harrison, N.J. (R)
129. Nova Chemical Corp., New York 14, N.Y. (C)
130. Nureco, Inc., 1100 Pontiac Ave., Cranston 10, R.I. (C)
131. Ohio Sealer and Chemical Corp., 2019 S. Broadway, Dayton 9, Ohio (C)
132. C.J. Osborn Co., 1301 W. Blancke St., Linden, N.J. (R)
133. Paisley Products, Inc., New York 19, N.Y. (C)
134. Parcloid Chemical Co., 31 Cross St., Midland Park, N.J. (C)
135. Pelron Corp., 7847 W. 47th St., Lyons, Ill. (C)
136. Pennsylvania Industrial Chemical Corp., Clairton, Pa. (R)
137. Petroleum Specialties, Inc., New York 17, N.Y. (R)
138. Phillips Petroleum Co., Bartlesville, Okla. (R)
139. Pierce and Stevens Chemical Corp., 710 Ohio St., Buffalo 3, N.Y. (C)
140. Pittsburgh Plate Glass Co., Paint Div., 1 Gateway Center, Pittsburgh, Pa. (C)
141. Plastics Engineering Co., 1607 Geele Ave., Sheboygan, Wis. (R)
142. Poly Resins, Sun Valley, Calif. (C)
143. Polymer Chemical Co., Cincinnati 12, Ohio (C)
144. Polypenco, Inc., 2150 Fairmont Ave., Reading, Pa. (C)
145. Protective Treatments, Inc., 420 Dellrose Ave., Dayton 3, Ohio (C)
146. Prufcoat Laboratories, Inc., Cambridge 42, Mass. (C)
147. Pyroxylin Products, Inc., Chicago 32, Ill. (C)
148. Raffi and Swanson, Inc., Wilmington, Mass. (C)
149. Rand Rubber Co., Brooklyn 16, N.Y. (R)
150. Randolph Products Co., Carlstadt, N.J. (C)
151. Reichhold Chemicals, Inc., White Plains, N.Y. (R)
152. Ren Plastics, Inc., 3179 S. Cedar Rd., Lansing 4, Mich. (C)
153. Resin Industries, Inc., Santa Barbara, Calif. (R)
154. Rexton Finishes, Inc., 62 Woolsey St., Irvington, 11, N.J. (C)
155. Reynolds Chemical Products Co., Ann Arbor, Mich. (C)
156. Rohm & Haas Co., Resinous Products Div., 222 W. Washington Sq., Philadelphia 5, Pa. (R)
157. Rubber and Asbestos Corp., Bloomfield, N.J. (C)
158. Rubber Corp. of America, Latex and Chemical Div., New South Road, Hicksville, Long Island, N.Y. (C)
159. Schenectady Resins Div., Schenectady Varnish Co., Inc., P.O. Box 1046, Schenectady 1, N.Y. (RC)
160. Schwartz Chemical Co., Inc., New York 23, N.Y. (C)
161. Seal-Peel, Inc., Van Dyke (Detroit), Mich. (C)
162. Semet-Solvay Petrochemical Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y. (R)
163. Servwell Products Co., 6541 Euclid Ave., Cleveland 3, Ohio (C)
164. Shawinigan Resins Corp., P.O. Box 2130, Springfield 2, Mass. (R)
165. Shell Chemical Corp., 380 Madison Ave., New York 17, N.Y. (R)
166. Sherwin-Williams Co., 101 Prospect, Cleveland 1, Ohio (RC)
167. Silicones Div., Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y. (R)
168. Soc-co Plastic Coating Co., 13216 Laureldale Ave., Paramount, Calif. (C)
169. Spraylat Corp., 1 Park Ave., New York 16, N.Y. (C)
170. Standard-Toch Chemicals, Inc., Staten Island 3, N.Y. (C)
171. Stanley Chemical Co., East Berlin, Conn. (C)
172. Sullivan Chemicals Div., Sullivan Varnish Co., 420 Hart St., Chicago 22, Ill. (C)
173. Synvar Corp., Wilmington 99, Del. (R)
174. Tennessee Eastman Co., Kingsport, Tenn. (R)
175. Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N.J. (R)
176. Thompson and Co., 1085 Allegheny Ave., Oakmont, Pa. (C)
177. Truscon Laboratories, Inc., Detroit 11, Mich. (C)
178. UBS Chemical Corp., Cambridge 42, Mass. (RC)
179. U. S. Stoneware Co., Akron 9, Ohio (C)
180. Varcum Chemical Corp., Packard Rd., Niagara Falls, N. Y. (R)
181. Velsicol Chemical Corp., 330 E. Grand Ave., Chicago 11, Ill. (R)
182. Warwick Chemical Co., Div. of Sun Chemical Corp., 10-10 44th Ave., Long Island City 1, N.Y. (R)
183. Watson-Standard Co., 225 Galveston Ave., Pittsburgh 30, Pa. (C)
184. Western Coating Co., Elyria, Ohio; Pasadena 1, Calif. (C)
185. Westinghouse Electric Corp., P.O. Box 1017, Pittsburgh, Pa. (C)
186. G. A. Wharry & Co., Inc., 95 Broad St., New York 4, N.Y. (R)
187. Wilcross Products Co., 20 Fourth Ave., Hawthorne, N.J. (C)
188. Witco Chemical Co., 122 E. 42nd St., New York 16, N.Y. (RC)
189. John H. Witte & Sons, Burlington, Iowa (R)
190. Wyandotte Chemicals Corp., Wyandotte, Mich. (R)
191. Wm. Zinsser and Co., 516 W. 59th St., New York 19, N.Y. (R)

*This chart includes information on sources of film-forming materials for compounding protective coatings, indicated by (R), and sources of protective coatings prepared from the film-forming materials, indicated by (C). Compounding usually involves the addition of water or organic solvents, plasticizers, colorants, defoamers, detackifiers, thickeners, antioxidants, stabilizers, etc.

Fibers Chart

PROPERTIES*	ACETATE	TRIACETATE	SAPONIFIED ACETATE		CUPRAMMONIUM RAYON
	Regular	*(Arnel)*†	*Fortisan*†	*Fortisan-36*	
Dimensions of fibers					
1. Continuous length	Yes	Yes	Yes	Yes	Yes
2. Staple length, in.	9/16 to 7	Any std. commercial length	–	–	1.5-7
3. Width, microns	11-73	17-40	3-9	3-9	5-11
4. Specific gravity at 25°C.	1.30-1.35	1.30	1.5	1.52	1.54
Tensile properties at break					
5. Tenacity 21°C. and 65% R.H., g./denier	1.1-1.4	1.2-1.4	7.0	8+	1.7-2.3
6. Tensile strength at 21°C. and 65% R.H., p.s.i.	18,000-23,000	20,000-23,000	138,000	155,000	33,000-42,000
7. Wet, percent of strength at 21°C., 65% R.H.	60-65	67-70	85	75	59
8. Ultimate elongation at 65% R.H., percent	23-30	25-40	6	6	10-17
Recovery from strain[b]					
9. Strain, percent	2 | 20	3-10	2 | 5	2 | 5	5 | 15
10. Recovery, percent	94 | 23	88-43	75 | 63	82 | 75	48 | 32
Modulus of elasticity					
11. Static method,[c] 10^{10} dynes/cm.^{2}	3.0-4.8	3.5-5.2	20.4-24.5	34	9.2
12. Static method,[c] g./denier	26-41	35-45	152-183	250	68
13. Velocity of sound method,[e] 10^{10} dynes/cm.^{2}	6.1	–	–	–	–
14. Velocity of sound method,[e] g./denier	52	–	–	–	–
15. Stiffness,[f] average, g./denier	5.2	5.3	120	135	14
16. Toughness index,[g] g.-cm./denier cm.	0.19[g]	.18	0.21	0.26	0.14
17. Moisture regain at 21°C., 65% R.H., percent	6.3-6.5	3.2	10.0-11.5	9-10	14-15
18. Swelling in water,[h] percent	15-30	–	18-26	–	99-134
Refractive index					
19. Epsilon[i]	1.478	1.472	1.547	1.551	1.548
20. Omega[j]	1.473	1.471	1.523	1.520	1.527
21. Dielectric constant[y]	3.8 at 60 cy. (0% R.H.) 5.0 at 60 cy. (50% R.H.)	4.1 at 60 cy. (dry) 3.7 at 10^6 cy. (dry)	–	–	–
22. Effect of age	Virtually none	Virtually none	Similar to cotton		Virtually none
23. Effect of heat, °F.	Becomes sticky 350 to 375	Scorching resistance exceptionally high; 86% of original strength retained after 11 days' exposure at 302	Similar to cotton		Decomposes 300; burns readily
24. Softening temperature, °F.	375-400 Melts at 500	Non-heat-treated softening point as measured in terms of safe ironing temperature 365. Heat-treated 465-482°, melting point 572.	–		–
25. Effect of sunlight, prolonged exposure	Loss of tensile strength No discoloration	Highly resistant under glass; unprotected sunlight exposure somewhat less.	Similar to cotton		Loss of tensile strength
26. Resistance to moths[l]	Not attacked	Not attacked	Not attacked		Not attacked
27. Resistance to mildew[m]	Resistant	Highly resistant; essentially undamaged by 12-wk. soil burial test	Similar to cotton		Attacked
28. Effect of strong acids	Decomposed	Degraded	Decomposed		Disintegrated by hot dilute or cold concentrated
29. Effect of weak acids	Dissolved by certain weak organic acids, such as acetic	Unaffected by dilute solutions of weak acids	Resistant		Similar to viscose
30. Effect of strong alkalies	Saponified	Slowly saponified; only slightly affected at low temperatures (mercerizing conditions)	Swelling and mercerization; loss of strength in hot conc.		Swelling and loss of strength
31. Effect of weak alkalies	Little or no effect for short periods; cold. Saponification on long standing or hot.	Little or no effect at 9.5 pH at 200°F. under normal scouring conditions	Little effect		Little effect if dilute
32. Effect of organic solvents	Insoluble in dry cleaning solvents generally; swollen or dissolved in acetone, ethyl acetate, many ketones and esters, glacial acetic acid, phenol, and some chlorinated solvents. Softened in alcohol	Unaffected by dry cleaning solvents; swollen by acetone, other ketones and trichloroethylene. Soluble in methylene chloride	Resistant		Resistant
33. Dyes used	Dispersed acetate dyestuffs; selected vats and azo colors; some acid and basic dyes; pigment dyes; solvent (swelling) dyeing	Selected dispersed "acetate" dyestuff; developed azo colors; selected sulfur and vat colors; solvent (swelling) dyeing	Dyes used for cotton; direct colors, sulfurs, naphthols, and vat dyes		Same as for viscose rayon

† Trade mark, see page 585.
* Footnotes are on page 585.

	VISCOSE RAYON						NYLON				ZEIN (*Vicara*)†		POLYTETRAFLUOROETHYLENE (*Teflon*)†
	Regular		*Medium tenacity*		*High tenacity*		*Continuous filament*			*Staple*			
							Regular		*High tenacity*				
1.	Yes		Yes		Yes		Yes		Yes	–	No		Yes
2.	1 to 8		1 to 8		No		–		–	1-1/8-6-1/2	1/2 to 6		Various
3.	10-43		8.4-43		10-15		11-43		16-43	14-43	15-41		–
4.	1.50-1.54		1.50-1.54		1.50-1.54		1.14		1.14	1.14	1.25		2.3
5.	1.5-2.4		2.4-3.0		3.0-4.6		4.5-6.0[r]		6.0-7.8[r]	4.0-4.8[r]	1.20-1.50		1.6
6.	29,000-47,000		47,000-58,000		58,000-88,000		65,000-88,000		88,000-114,000	58,000-70,000	20,000-24,000		47,000
7.	44-54		56-63		55-63		85-90		85-90	85-90	60-65		100
8.	15-30		10-20		9-20		25-31[r]		15-23[r]	33-45[r]	25-35		13
9.	2	20	2	20	2	15	2	8[a]	4[a]	–	2	5[a]	–
10.	82	30	82	30	82	37	100	100	100	–	96	80	–
11.	6.4-9.1		12.5		9.9-23.6		3.0		–	1.5	3.1[t]		–
12.	48-68		93		74-176		30		–	15	28[t]		16
13.	11.5-13		20		20-33.8		6.0		–	–	5.0		–
14.	86-96		147		150-252		abt. 60		–	–	45		–
15.	8.7		17		25		14-24[f]		26-52[f]	9-15[f]	3.9		–
16.	0.23		0.22		0.25		0.54-0.70[r]		0.59-0.69[r]	0.79-0.90[r]	0.18		–
17.	11.5-16.6		11.5-16.6		11.5-16.6		4.0-4.5				10		0
18.	45-82		45-82		45-82		About 2				20		0
19.	1.547		1.547		1.547		1.547				1.534		–
20.	1.521		1.521		1.521		1.521				1.534		–
21.	–		–		–		4.0 at 1 kc. (18% R.H.) 20.0 at 1 kc. (wet)				–		–
22.	Slight yellowing						None				None		–
23.	Does not melt; decomposes 350-400; burns readily						Becomes sticky at 400-455				Begins to deteriorate at 350		Decomposes above 525
24.	–						Melts at about 415-480 (Nylon 66 melts at 482)				478-482		–
25.	Loss of tensile strength						Some loss of strength. No discoloration				Slow deterioration and loss of strength		–
26.	Not attacked						Not attacked				Resistant		Not attacked
27.	Attacked						Not attacked				Resistant		Not attacked
28.	Similar to cotton						Disintegrated by conc. mineral acids				Resistant		Not attacked
29.	Strength deterioration on prolonged contact or hot						Generally good resistance				Very resistant		Not attacked
30.	Swelling and loss of strength						Virtually none				Resistant		Not attacked
31.	No effect cold; reduced strength hot or on prolonged contact						None				Very resistant		Not attacked
32.	Resistant						Unaffected by dry cleaning solvents. Soluble in some phenolic compounds and in conc. (90%) formic acid				Resistant		Not attacked
33.	Acid (for tinting only); basic; direct; vat; naphthols; sulfur						Disperse and acid are usually preferred, but most other classes are also used				All usual types, including both acid and wool dyes and alkaline dyes		May be stained by acetate colors

†Trade mark, see page 585.

PROPERTIES*	POLYESTER (Dacron)†				VINYL CHLORIDE-VINYL ACETATE	VINYLIDENE CHLORIDE RESIN (Saran)		
	Filament			Staple[p]	Staple	Monofilaments	Continuous multifilaments	Staple
	Regular	High tenacity						
Dimensions of fibers								
1. Continuous length	Yes	Yes		–	–	Yes	Yes	No
2. Staple length, in.	–	–		1-1/2-4-1/2	1 to 5	–	–	1-1/2 up
3. Width, microns	11-23	21		12-25	16-18	100-1300	35-100	35-100
4. Specific gravity at 25°C.	1.38	1.38		1.38	1.33-1.36	1.70 ± .05	1.70 ± .05	1.70 ± .05
Tensile properties at break								
5. Tenacity 21°C. and 65% R.H., g./denier	4.6-5.0[r]	6.0-7.0		3.8-4.4	0.6-0.7	1.1-2.9	Up to 2	Up to 2
6. Tensile strength at 21°C. and 65% R.H., p.s.i.	81,000-88,000	106,000-124,000		67,000-78,000	10,000-12,000	25,000-60,000	Up to 44,000	Up to 44,000
7. Wet, percent of strength at 21°C., 65% R.H.	100	100		100	100	100	100	100
8. Ultimate elongation at 65% R.H., percent	19-23	10-13		36-42	10-13	20-35	15-25	15-35
Recovery from strain[b]								
9. Strain, percent	2	2	8	– –	–	10	3 10	–
10. Recovery, percent	97	100	90	– –	–	95 (5 min.)	98.5 93 (5 min.)	–
Modulus of elasticity								
11. Static method,[c] 10^{10} dynes/cm.^{2}	12.2	14.6		6.1	3.3-4.5[d]	.3-1.7	–	–
12. Static method,[c] g./denier	100	120		50	28-38[d]	2-11	6-10	6-10
13. Velocity of sound method,[e] 10^{10} dynes/cm.^{2}	14.6	–		–	–	–	–	–
14. Velocity of sound method,[e] g./denier	Abt. 120	–		–	–	–	–	–
15. Stiffness,[f] average, g./denier	20-26	46-70		9-12	5.8	10	8-12	8-12
16. Toughness index,[g] g.-cm./denier cm.	0.50	0.37		0.80	0.04	.165-.265	.125	.125
17. Moisture regain at 21°C., 65% R.H., percent	0.4				0	0		
18. Swelling in water,[h] percent	Virtually none				0	0		
Refractive index								
19. Epsilon[i]	–				1.536	1.60-1.63		
20. Omega[j]	–				1.536	1.60-1.63		
21. Dielectric constant	3.8 at 60 cycles (dry)				–	3.0-5.0 at 60 cy., 1 kc., 1 mc.		
22. Effect of age	None				None	Slight		
23. Effect of heat, °F.	Resistant to degradation by heat Melts at 480				Melts at 260 Does not burn	Strength loss occurs at 160-200		
24. Softening temperature, °F.	Sticks at 455				Softens at 170	Shrinks at 160-250 if not under restraint; softens at 240-280		
25. Effect of sunlight, prolonged exposure	Some loss of strength. No discoloration. Much more resistant behind glass than in direct sunlight				None	Darkens slightly		
26. Resistance to moths[l]	Not attacked				Not attacked	Not attacked		
27. Resistance to mildew[m]	Not attacked				Not attacked	Not attacked		
28. Effect of strong acids	Very resistant to most mineral acids. Disintegrated by 96% sulfuric				Stable	Stable		
29. Effect of weak acids	Virtually none				Stable	Stable		
30. Effect of strong alkalies	Resistant when cold. Disintegrated at boil				Stable	Stable to most; limited resistance to ammonia		
31. Effect of weak alkalies	Good resistance				Stable	Stable		
32. Effect of organic solvents	Generally unaffected. Soluble in some hot phenolic compounds				Soluble in ketones and some chlorinated hydrocarbons; swells and softens in ethers, esters, aromatic hydrocarbons, dioxane, propylene oxide.	Swelled or softened by oxygen-bearing solvents (cyclohexanone, dioxane) at elevated temperatures		
33. Dyes used	Disperse, azoic, and vat with carrier or at high temperatures				Dispersed dyes with aid of certain swelling agents; solvent methods; pigment dyeing.	Colored before extrusion	Colored before extrusion. Selected acetate type dyestuffs	Colored before extrusion. Selected acetate type dyestuffs

†Trade mark, see page 585.
*Footnotes are on page 585.

	ACRYLICS									POLYETHYLENE *Monofilaments*	
	Dynel† *Staple*	Orlon† *Staple*	Acrilan† *Staple*			Creslan† *Staple*	Acrylast† *Filament*			*Low density*	*High density*
1.	–	–	–			–	Yes			Yes	Yes
2.	1-1/4 to 5 or tow	1-1/8-4-1/2	1.5-5.0 and tow			1.5-4.5	–			–	–
3.	Ratio of width to thickness 5-6: 1	14-27[q]	15-30			16.5-21.5	45-1200			100-1500	100-1500
4.	1.30	1.14	1.173			1.17	1.09-1.10			0.92	0.94-0.96
5.	2.5-3.3	1.9-2.3[r]	2.5			2.8-3.5	1.4-2.5			1.0-2.7	5.0-8.0
6.	50,000	28,000-34,000	37,500			45,000-52,000	20,000-35,000			11,000-33,000	50,000-96,000
7.	100	–	80			–	100			100	100
8.	30-42	20-25[r]	36			35-40	40-50			20-100 (oriented)	10-30
9.	2[d]	–	2	5	10	1	2	8		5[d]	5 10
10.	97	–	99	89	67	87	100	35		95	95 80
11.	4.1	5.0	–			–	–			–	–
12.	35	50	44			43	Ca. 30			–	20-40
13.	–	–	–			–	–			–	–
14.	–	–	–			–	–			–	–
15.	8.2	8-12	7.0			9.0	Ca. 30[x]			2-12	20-40[x]
16.	0.53	0.24[g]	0.46			.70	.4-.5			0.3	0.4-0.8
17.	<0.4	1.5	1.24-1.59			2.0	.5 max.			0	0
18.	Very slight	Slight	Slight			Very slight	0			0	0
19.	–	–	1.522			–	–			–	–
20.	–	–	–			–	–			–	–
21.	–	4.8 at 60 cycles (dry)	3.1 at 10^3 cycles 2.8 at 10^6 cycles			–	3.4 at 60 cycles 3.1 at 10^6 cycles			–	2.3 at 1 kc. and 1 mc.
22.	Virtually none	None	Virtually none			Virtually none	None			Virtually none at room temp.	
23.	Shrinks at 250	Resistant to degradation by heat	Shrinks 5% at 487 10% at 511			–	Shrinks at 180			5% shrinkage at 165	1-4% shrink at 160; 5-10% shrink at 212
24.	Strain release occurs above 240 unless fiber is stabilized	Sticks at 455-480	Sticks at 475			Sticks at 392	240-280			Melts at 230-250	Softens at 240-250 Melts at 250-270
25.	Some loss of tensile strength	Very high resistance to sunlight deterioration	Very resistant			–	Slight yellowing. No loss of strength			Some loss of tensile for clear; much less for pigmented. No darkening	
26.	Not attacked	Not attacked	Not attacked			Not attacked	Not attacked			Not attacked	
27.	Not attacked	Not attacked	Not attacked			Not attacked	Not attacked			Not attacked	
28.	Very resistant, except to: 25% chromic 70% nitric 96% sulfuric	Very resistant to most mineral acids. Disintegrated by 96% sulfuric	Resistant			Generally resistant	Fair resistance to HCl and H_2SO_4. Poor resistance to HNO_3.			Very resistant	
29.	Little or no effect	Virtually none	Little or no effect			Stable	Virtually none			Very resistant	
30.	Very resistant, except to high conc. of NaOH above 70%	Resistant when cold. Disintegrated at boil	Resistant			Loss of strength	Good resistance			Very resistant	
31.	Not attacked	Good resistance	Good resistance			Slight yellowing	None			Very resistant	
32.	Generally resistant but dissolved by acetone, partially dissolved by higher ketones, aniline, and ethylene dichloride.	Unaffected by common solvents	Insoluble in benzene, acetone, petroleum ether, ethyl alcohol dichloroethane, carbon tetrachloride, solvent naphtha, dioxane and others			Unaffected by common solvents	Not resistant to acetone, methylethyl ketone, benzene, orthodichlorobenzene, dioxane, pyridene, carbon disulfide. Resistant to motor oils, some gasolines and kerosenes, normal heptane, food oils, higher alcohols.			Soluble above 160°F. in some solvents	
33.	Acetate, acid, direct, basic and some vat dyes.	Acid (copper technique), naphthols, basic, acetate, and vat	Acid, chrome, premetallized, acetate, basic, and vat. Ordinary dyeing procedures used			Acid, chrome, metallized, acetates, selected directs, and basics				Pigmented before extrusion	

†Trade mark, see page 585.

PROPERTIES	COTTON	SILK	WOOL	GLASS	ASBESTOS
Dimensions of fibers					
1. Continuous length	No	400 to 1300 yards	No	Yes	No
2. Staple length, in.	1/2 to 2-1/2	Yes	1-1/2 to 15	Up to 18	Up to 3/4
3. Width, microns	12-20	9-11	10-70	5-10	–
4. Specific gravity at 25°C.	1.50-1.55	1.25-1.35	1.28-1.33	2.54	2.5
Tensile properties at break					
5. Tenacity 21°C. and 65% R. H., g./denier	2.1-6.3	2.8-5.2	1.0-1.7	7.7	–
6. Tensile strength at 21°C. and 65% R. H., p.s.i.	42,000-125,000	45,000-83,000	17,000-28,000	250,000-315,000	200,000-400,000
7. Wet, percent of strength at 21°C., 65% R.H.	110-130	75-95	76-97	99	90-100
8. Ultimate elongation at 65% R.H., percent	3-10	13-31	20-50	2.5-3.15	–
Recovery from strain[b]					
9. Strain, percent	2 | 5	2 | 20	2 | 20	3[d]	–
10. Recovery, percent	74 | 45	92 | 33	99 | 63	100	–
Modulus of elasticity					
11. Static method,[e] 10^{10} dynes/cm.^{2}	5.7-11.2	8.4-12.9	2.7-3.9	68.9	–
12. Static method,[c] g./denier	42-82	76-117	24-34	307	–
13. Velocity of sound method,[e] 10^{10} dynes/cm.^{2}	–	14.4	5.1	74	–
14. Velocity of sound method,[e] g./denier	–	130	44	331	–
15. Stiffness,[f] average, g./denier	60	18	3.9	300	–
16. Toughness index,[g] g.-cm./denier cm.	0.15	0.44	0.25	0.13	–
17. Moisture regain at 21°C., 65% R. H., percent	8.5	11.0	17.0	0	–
18. Swelling in water,[h] percent	44-49	30-41	32-38	0	–
Refractive index					
19. Epsilon[i]	1.580	1.591	1.556	1.55 ± 0.01	–
20. Omega[j]	1.533	1.538	1.547	1.55 ± 0.01	–
21. Dielectric constant	– [e]	4.2 at 500 kc., 4 mc., 10 mc.	4.2 at 13 mc. 500 kc., 120 kc. 4.8 at 20 kc. 5.4 at 8 kc.	6.3 at 60 cy. 6.3 at 1 mc. 5.8 at 10 mc. 5.6 at 37 mc.	–
22. Effect of age	Virtually none	Slight yellowing; slight loss of tensile	Slight yellowing; slight loss of tensile	None	None
23. Effect of heat, °F.	Yellows at 248 Decomposes at 302 (5 hrs.)	1% shrinkage at 350	Decomposes 266 Scorches 400 Chars 572	No loss at 475 50% loss at 685	Very little up to 900
24. Softening temperature, °F.	–	–	–	1380-1550	Melts at 2770
25. Effect of sunlight, prolonged exposure	Loss of tensile; tendency for whites to yellow	Loss of tensile strength	Loss of tensile. Dyeing affected	None	None
26. Resistance to moths[l]	Not attacked	May be attacked but less than wool	Attacked	Not attacked	Not attacked
27. Resistance to mildew[m]	Attacked, especially if sized	Not usually attacked	May be attacked but more resist. than cotton	Not attacked	Not attacked
28. Effect of strong acids	Disintegrated by hot dilute or cold conc.	Dissolved	Destroyed by hot sulfuric; resistant to others	Attacked by hydrofluoric and hot phosphoric	Affected
29. Effect of weak acids	Stable if cold; strength deterioration if hot	Moderately resistant	Resistant	Stable	Resistant
30. Effect of strong alkalies	Swelling and mercerization	Dissolved	Attacked	Attacked	Resistant
31. Effect of weak alkalies	Little effect	Attacked if hot	Attacked if hot	Attacked if hot	Resistant
32. Effect of organic solvents	Resistant	Resistant	Resistant	Insoluble	Insoluble
33. Dyes used	Basic, direct, mordant, sulfur, vat, naphthols	Acid, basic, direct, mordant, naphthols, vat	Acid, basic, direct, mordant, vat	Resin-bonded pigments; also other dyes used on coated fibers	–

Synthetic Fibers[a]: Manufacturers[v] and Trade Names

Acetate

Avisco. American Viscose, 1617 Pennsylvania Blvd., Philadelphia 3, Pa.

Celanese, Celaperm, Lanese. Celanese Corp. of America, 180 Madison Ave., New York 16, N.Y.

DuPont acetate. E.I.duPont de Nemours & Co., Inc., Wilmington 98, Delaware.

Teca, Estron, Chromspun. Estron and Chromspun Acetate Fiber, Eastman Chemical Products, Inc., Kingsport, Tennessee.

Triacetate

Arnel. Celanese Corp. of America, 180 Madison Ave., New York 16, N.Y.

Partially Saponified Acetate

Celcos. Celanese Corp. of America, 180 Madison Ave., New York 16, N.Y.

Rayon, Saponified Acetate

Fortisan. Celanese Corp. of America, 180 Madison Ave., New York 16, N.Y.

Rayon, Cuprammonium

Bemberg, Matesa. American Bemberg, 261 Fifth Avenue, New York 16, New York.

Rayon, Viscose

Avisco. American Viscose Corp., 1617 Pennsylvania Blvd., Philadelphia 3, Pennsylvania.

Briglo, Englo, Enka, Jetspun, Perlglo, Superenka, Tempra. American Enka Corp., 206 Madison Ave., New York 16, N.Y.

Chardonize, Hygram, Tubize. Celanese Corp. of America, 180 Madison Ave., New York 16, N.Y.

Chromaset, Duralon. Delaware Rayon Div., Greenville Mills, Inc., New Castle, Delaware.

Cordura, Super Cordura. DuPont rayon. E.I. duPont de Nemours & Co., Inc., Wilmington 98, Del.

Covingtone, Suede-Skin, Spun-Black, Superwind, Dul-Tone, Spun-Lo, Tyron, Nupron, Premier, Covinair, Lektroset. Industrial Rayon Corp., Union Commerce Bldg., Cleveland 1, Ohio.

Narco, Hi-Narco, Super-Narco, Semi-Dul, Xtra-Dul. North American Rayon Corp., 261 Fifth Ave., New York 16, N.Y.

Newbray, Newdull, Newlow. New Bedford Rayon Company, Box 908, New Bedford, Massachusetts.

Veri-Dul. Skenandoa Rayon Corp., 261 Fifth Ave., New York 16, N.Y.

Nylon

Chemstrand nylon. Chemstrand Corp., 350 Fifth Ave., New York 1, N.Y.

Dawbarn nylon. Dawbarn Brothers, Inc., Waynesboro, Va.

DuPont nylon. E. I. duPont de Nemours & Co., Inc., Wilmington 98, Delaware.

Enka, Nylenka. American Enka Corp., 206 Madison Ave., New York 16, N.Y.

Firestone nylon monofilament. Firestone Plastics Co.; Div. of Firestone Tire and Rubber Co., Pottstown, Pa.

Industrial Rayon Corp. nylon. Industrial Rayon Corp., 500 Fifth Ave., New York 36, N.Y.

Polyester

Dacron. E. I. duPont de Nemours & Co., Inc., Wilmington 98, Delaware.

Zein

Vicara. Virginia-Carolina Corp., Fiber Div., Taftville, Connecticut.

Polytetrafluoroethylene

Teflon. E. I. duPont de Nemours & Co., Inc., Wilmington 98, Del.

Vinyl Chloride-Vinyl Acetate Resin

Vinyon HH. American Viscose Corp., 1617 Pennsylvania Blvd., Philadelphia 3, Pa.

Vinylidene Chloride Resin

Bolta saran. Bolta Products, Div. of The General Tire and Rubber Co., Lawrence, Mass.

Dawbarn saran. Dawbarn Brothers, Inc., Waynesboro, Virginia.

Lus-Trus saran. Lus-Trus Corp., 884 Railroad St., Ypsilanti, Mich.; also Southern Lus-Trus Corp., 1048 Escambia St., Jacksonville, Fla.

National saran. National Plastics Products Co., Odenton, Maryland.

Velon. Firestone Plastics Co., Pottstown, Pennsylvania.

—Saran Co., Odenton, Md.

Acrylic

Acrilan. Chemstrand Corp., 350 Fifth Avenue, New York 1, N.Y.

Acrylast. Dawbarn Brothers, Inc., Waynesboro, Va.

Creslan. American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.

Dynel. Carbide & Carbon Chemicals Corp., 30 East 42nd St., New York 17, N.Y.

Orlon. E. I. duPont de Nemours & Co., Inc., Wilmington 98, Delaware.

Polyethylene

DLP. Dawbarn Brothers, Inc., Waynesboro, Virginia.

Firestone. Firestone Plastics Co., Box 690, Pottstown, Pennsylvania.

Reevon. Reeves Brothers, Inc., 54 Worth Street, New York 13, N.Y.

Wynene. National Plastics Products Company, Odenton, Maryland.

Glass

Fiberglas. Owens-Corning Fiberglas Corp., Textiles Division, 16 East 56th Street, New York 22, N.Y.

Garan, Vitron. L-O-F Glass Fibers Co., 1810 Madison Avenue, Toledo 1, Ohio.

Modiglass. Modigliani Glass Fibers, Inc., 70 Pine St., New York 5, N.Y.

Pittsburgh PPG. Pittsburgh Plate Glass Co., Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pa.

Unifab, Uniformat, Unirove. Ferro Corporation, Fiber Glass Division, Fiber Glass Road, Nashville 11, Tennessee.

---

[a] This compilation of the principal physical and chemical properties of the commercially important textile fibers was originally prepared for the Modern Plastics Encyclopedia by Harris Research Laboratories.

[b] Except as otherwise noted, all values for elastic recovery were obtained at 20 °C. and 65% relative humidity; rate of loading 10 g./denier/min.; duration of action of load 30 sec.; recovery time 60 sec.

[c] Except as otherwise noted, all values for static method were obtained under the same conditions described in footnote (b).

[d] Testing conditions not reported.

[e] All values by the velocity of sound method were obtained in air-dry condition.

[f] Stiffness (resistance to deformation) is the ratio of breaking stress to breaking strain, P/E, where P is the stress in grams per denier required to produce rupture and E is the strain in centimeters per gauge centimeter at breaking stress.

[g] Toughness (the ability to absorb work), expressed as a toughness index, is the work per unit (denier and length) or weight of material which would cause rupture if the stress-strain curve were a straight line: PE/2.

[h] Values pertain to cross-section area increase, essentially equivalent to volumetric swelling.

[i] Index for light vibrating parallel to the long fiber axis.

[j] Index for light vibrating perpendicular to the long fiber axis.

[l] Many materials are subject to attack by moths if they contain edible finishes.

[m] Resistance of yarns and fabrics to mildew depends in many cases upon the nature of the finishing materials used.

[n] Rate of loading 1 g./denier/minute.

[o] Stretched: rate of loading 7.5 g./denier/min.; duration of action of load 40 sec.; recovery time 60 sec.; stabilized: rate of loading 4 g./denier/min.; duration of action of load 45 sec.; recovery time 60 sec.

[p] Measurements made on uncrimped tow.

[q] Based on circular cross-sections. "Orlon" has "dog-bone" cross-section.

[r] Nylon and "Dacron" measured on Single End "Suter" Tester. "Orlon" measured on "IP-4" (16 g./d./min.).

[s] Recovery against no load, samples loaded and load released immediately, recovery within 60 seconds (75 °F., 65% R.H.).

[t] "Instron" Tester, 10% per min. rate of elongation (75 °F., 72% R.H.).

[u] $n_D/20$ °C. = 1.530 obtained on pressed disk of "Vinyon" N resin. Birefringence could not be detected in this manner.

[v] Where executive offices and plants have different locations, the addresses listed are for the executive offices.

[w] Fiber in experimental production only.

[x] Stiffness determined at yield point.

[y] Determined on film.

Laminates Chart

PROPERTIES[a]	DIALLYL PHTHALATE LAMINATES		POLYESTER LAMINATES				VULCANIZED FIBRE (in general, low thicknesses give high values)
	Glass fabric base	*Cotton fabric base*	*Glass fabric base*	*Glass mat base*	*Paper base*	*Cotton base*	
1. Laminating temp., °F.	200-300	200-300	R.T.-300	R.T.-300	180-250	180-300	–
2. Laminating pressure, p.s.i.	10-1500	10-1500	10-150	10-150	0-10	0-10	–
3. Specific gravity, D792	1.65	1.38	1.5-2.1	1.5-1.9	1.2-1.5	1.2-1.4	0.9-1.5
4. Specific volume, cu. in. per lb., D792	16.8	20.1	18.5-13.2	18.5-14.4	23.0-18.5	23.0-19.7	30.0-18.5
5. Tensile strength, D638, p.s.i.	21000-29000	8500-10500	40000-50000	10000-24000	6100-14300	7000-9000	5000-12000
6. Modulus of elasticity in tension, D638, 10^5 p.s.i.	–	–	10-28	10-19	8-12	–	8-12
7. Compressive strength, D695, p.s.i.	45000	40000	30000-60000	30000-50000	19700-25000	23000-24000	20000-30000
8. Modulus of elasticity in compression, D695, 10^5 p.s.i.	–	–	30-40	–	–	–	–
9. Flexural strength, D790, p.s.i.	42000-50000	12000-17000	50000-63000	15000-35000	12800-23500	13000-18000	12000-20000
10. Modulus of elasticity in flexure, D790, 10^5 p.s.i.	–	–	20-30	10-18	8-13	–	7-10
11. Shear strength, D732, p.s.i.	17800-20000	14000-14700	12000-18000	–	–	–	–
12. Modulus of elasticity in shear, 10^5 p.s.i.	–	–	5-7	–	–	–	–
13. Bearing strength, D953, p.s.i.	–	–	40000-50000	–	–	–	–
14. Impact strength, Izod, D256, ft.-lb. per in. of notch	4.3-6.7	0.8-1.2	19-35	8-15	–	1.5-2.3	1.0-8.0
15. Bond strength, D952, lb.	1300	1100	–	700-1200	–	–	1000
16. Hardness, Rockwell, D785	M120	M110	M100-M110	M90-M105	–	–	R50-R100
17. Thermal conductivity, C177, 10^{-4} cal./sec./sq. cm./1°C./cm.	–	6.3-6.6	–	–	–	–	3-5
18. Specific heat, cal. per °C. per gm.	–	–	0.25-0.26	–	–	–	0.4
19. Thermal expansion, D696, 10^{-5} per °C.	–	–	–	–	3.1	–	2.3
20. Resistance to heat (continuous),[b] °F.	300	–	300-400	250	220-250	250	225
21. Heat distortion temp., D648, °F.	–	–	–	–	240	–	–
22. Insulation resistance (96 hr. at 90% R.H. and 35°C.), D257, megohms	150	–	–	1000-50000	–	–	–
23. Volume resistivity (50% R.H. and 25°C.), D257, ohm-cm.	–	–	–	10^6-10^{12}	10^{13}	–	–
24. Dielectric strength, short-time, 1/8-in. thickness, D149, volts per mil	530	390	200-600	250-600	600-800	300-500	150-250
25. Dielectric strength, step-by-step, 1/8-in. thickness, D149, volts per mil	–	–	–	200-450	400-600	270-400	75-200
26. Dielectric strength, step-by-step, ‖ to lamination, KV/in.	75	40	–	40-60	–	–	–
27. Dielectric constant, 60 cycles, D150	4.3	5.1	–	4.3-4.8	5.1	–	–
28. Dielectric constant, 10^3 cycles, D150	–	–	–	–	–	–	4.7
29. Dielectric constant, 10^6 cycles, D150	4.1	4.8	–	4.0-4.7	3.0-4.2	3.1-3.3	
30. Dissipation factor, 60 cycles, D150	0.013	0.015	–	0.005-0.05	0.1	–	–
31. Dissipation factor, 10^3 cycles, D150	–	–	–	0.005-0.04	–	–	0.03-0.08
32. Dissipation factor, 10^6 cycles, D150	0.015	0.018	–	0.007-0.04	0.03	0.03-0.04	
33. Arc resistance, D495, sec.	150	130	80-120	10-180	28-75	70-85	110-150
34. Water absorption, 24 hr., 1/8-in. thickness, D570,%	0.12	0.60	0.3-0.9	0.3-1.0	1.5	1.3-1.6	18-65
35. Burning rate, D635	–	–	Slow to nil	Slow to nil	Moderate to self-extinguishing		Slow
36. Effect of sunlight	Nil	Nil	Approx. nil	Approx. nil	Slight darkening		Slight
37. Effect of weak acids, D543	None	None	None	None	None	None	Embrittled by some
38. Effect of strong acids, D543	Slight	Decomposes	Some attack	Some attack	Some attack	Some attack	Embrittled
39. Effect of weak alkalies, D543	None	None	Slight	Slight	Slight	Slight	Swells
40. Effect of strong alkalies, D543	Slight	Attacked	Attacked	Attacked	Attacked	Attacked	Swells
41. Effect of organic solvents, D543	None	None	Generally nil	Generally nil	Generally nil	Generally nil	None
42. Machining qualities	Fair	Good	Fair	Fair	Excellent	Excellent	Good to excellent
43. Trade designations (see list of manufacturers on page 589 for key to numbers)	Conolite (6), Dilecto (7), Dryply (13), Formica (14), Gilfab (16), Glastic (17), Insurok (29), Lamidall (39), Micarta (37), Panelyte (26), Phenolite (24), Repcoboard (31), Sunform (9), Synthane (35), Textolite (15), Trevarno (4), Tropiglas (31), Wallfab (16), Zenaloy (40)						Diamond (7), Duroid (30), National (24), Peerless (24), Spaulding (34), Taylor (36), Vulcoid (7), Wilmington (38)
44. Manufacturers (See list on page 589 for key to numbers)	4, 6, 7, 9, 10, 13, 14, 15, 16, 17, 20, 24, 26, 31, 35, 37, 39, 40						7, 24, 30, 34, 36, 38

PHENOL-FORMALDEHYDE LAMINATES

	Cellulose paper base	*Cotton fabric base*	*Cotton web base*	*Nylon fabric base*	*Glass fabric base*	*Asbestos fabric base*	*Asbestos paper base*	*Wood base*
1.	275-350	275-350	275-350	275-325	275-350	300-350	300-350	300-320
2.	1000-1800	1000-1800	1000-1800	1000-1800	1000-1800	1000-1800	1000-1800	1000-2000
3.	1.28-1.40	1.30-1.36	1.31-1.37	1.15-1.19	1.4-1.8	1.55-1.80	1.65-1.83	1.3
4.	21.8-19.7	21.3-20.4	21.1-20.2	24.0-23.2	19.7-15.4	17.8-15.4	16.8-15.1	21.3
5.	8000-20000	9000-16000	14000-16000	5000-9500	9000-25000	10000-12000	5000-15000	16000-32000
6.	8-20	5-15	6-11	3.6	10-20	3.5-15	–	37
7.	20000-40000	30000-44000	32000-47000	28000-36000	40000-60000	30000-40000	40000	12000-21000
8.	8	6	4-8	–	–	7	5	–
9.	10500-30000	16000-30000	18000-25000	9000-22000	20000-30000	10000-35000	18000-20000	25000-40000
10.	8-15	8-10	6-10	7-10	1.8-2.5	12	–	–
11.	9000-14000	14000-18000	12600-14000	10000-13700	17200-24000	19000-21000	9000-13500	–
12.	–	–	–	–	–	–	–	–
13.	–	–	–	–	–	–	–	–
14.	0.4-1.0	1.0-2.5	1.4-2.5	2.0-4.0	4.0-8.0	3.5-5.0	0.8-1.9	4-8
15.	700-1400	1200-2500	1000-1600	1000-1500	800-1600	1500-2200	600-1000	–
16.	M70-M120	M90-M115	M100-M110	M100-M110	M105-M110	M70-M115	M100	M90-M105
17.	1.8	2.1-2.3	–	–	1.4-1.8	4.6	–	–
18.	0.38-0.41	0.35-0.38	–	–	0.23-0.27	–	–	0.2-0.4
19.	1.4-3.0	1.8-3.2	1.3-1.6	4	1.5-2.5	1.7-2.5	1.0-1.6	0,6 ⊥, 6.5 ∥
20.	225-250	225-250	225	165	290	275	275	150-200
21.	250-> 320	> 320	> 320	165	> 320	> 320	> 320	> 320
22.	35-200,000	10-5000	10-200	30000-50000	25-500	–	–	0.25-335
23.	10^{10}-10^{13}	10^{10}-10^{12}	–	7×10^{13}	2.5×10^{10}	–	–	–
24.	300-1000	150-600	200	360-600	300-900	50-100	160-250	75-500
25.	260-800	120-440	150	300-450	250-700	50-75	120-200	–
26.	15-70	10-60	10-40	40-100	30-50	5-15	4-25	–
27.	4.5-7.5	5.0-10	–	3.7-4.2	–	–	–	–
28.	4.2-6.0	4.2-6.5	–	3.6-4.1	4.8	7.5	7.0	–
29.	3.6-6.0	5.0-7.0	5.5-7.0	3.3-3.9	3.7-6.0	5.5-7.0	5.2	5
30.	0.02-0.10	0.04-0.50	0.10-0.5	0.01-0.02	0.01-0.02	–	–	0.20
31.	0.03-0.07	0.04-0.09	–	0.01-0.02	0.015-0.017	0.06-0.10	0.15-0.20	–
32.	0.02-0.08	0.05-0.10	0.06-0.10	0.015-0.040	0.01-0.05	0.10-0.15	0.08-0.14	0.05
33.	Tracks	Tracks	Tracks	Tracks	Tracks	Tracks	Tracks	Tracks
34.	0.2-3.0	0.8-2.0	1.2-1.6	0.2-0.35	0.3-1.5	0.3-2.5	0.4-2.0	2.5-11
35.	Very low	Very low	Very low	Slow	Nil	Approx. nil	Approx. nil	Very low
36.	Lowers surface resistance and general darkening							
37.	None to slight depending on acid							
38.	Decomposed by oxidizing acids; reducing and organic acids none to slight effect							
39.	Slight to marked depending on alkalinity and grade							
40.	Attacked by strong alkalies unless a special alkali-resistant resin is used							
41.	None on bleed-proof materials							
42.	Fair to excellent				Fair to good			Good
43.	Aqualite (24), Capac (3), Celoron (7), Consoweld (5), Decarlite (8), Dilecto (7), Farlite (12), Formica (14), Gilfab (16), Hi-Den (27), Insurok (29), Lamicoid (22), Micarta (37), Nevamar (23), Norplex (25), Ohmoid (38), Panelyte (26), Phenolite (24), Pregwood (14), Resilyte (2), Ryertex (32), Spauldite (34), Synthane (35), Taylor (36), Tensilite (19), Textolite (15), Trevarno (4)							
44.	2, 3, 4, 5, 7, 8, 11, 12, 14, 15, 16, 18, 19, 22, 23, 24, 25, 26, 27, 29, 32, 34, 35, 36, 37, 38, 40							

PROPERTIES[a]	EPOXY LAMINATES	MELAMINE-FORMALDEHYDE LAMINATES				
	Glass fabric base	*Cellulose paper base*	*Cotton fabric base*	*Asbestos paper or fabric base*	*Glass fabric base*	*Glass mat*
1. Laminating temp., °F.	180-370	270-320	270-320	270-320	270-320	270-320
2. Laminating pressure, p.s.i.	10-1800	1000-1800	1000-1500	1000-1800	1000-1800	1000-1800
3. Specific gravity, D792	1.7-1.9	1.40-1.55	1.35-1.5	1.75-1.85	1.82-1.98	1.80
4. Specific volume, cu. in. per lb., D792	16.3-14.5	19.1-17.8	20.5-18.5	15.8-14.9	15.2-13.9	15.4
5. Tensile strength, D638, p.s.i.	33000-50000	10000-25000	9000-19000	6000-12000	25000-40000	16000-25000
6. Modulus of elasticity in tension, D638, 10^5 p.s.i.	25-35	–	10-19	16-22	–	–
7. Compressive strength, D695, p.s.i.	50000-90000	30000-48000	33000-46000	27000-50000	30000-85000	60000
8. Modulus of elasticity in compression, D695, 10^5 p.s.i.	–	–	–	–	47	–
9. Flexural strength, D790, p.s.i.	45000-80000	14000-20000	14000-26000	12000-24000	40000-65000	21000-28000
10. Modulus of elasticity in flexure, D790, 10^5 p.s.i.	20-36	–	–	–	20-30	13
11. Shear strength, D732, p.s.i.	17000-22000	–	16500-18000	13000-17000	19000-35000	–
12. Modulus of elasticity in shear, 10^5 p.s.i.	–	–	–	–	–	–
13. Bearing strength, D953, p.s.i.	–	–	–	–	–	–
14. Impact strength, Izod, D256, ft.-lb. per in. of notch	10-25	0.3-1.5	0.5-1.7	0.75-4	5-15	5-5.5
15. Bond strength, D952, lb.	1600-2700	1000	1500-2500	800-1500	1500-2300	1400-2000
16. Hardness, Rockwell, D785	M105-M120	M110-M125	M110-M120	M110-M118	M115-M130	M115-M125
17. Thermal conductivity, C177, 10^{-4} cal./sec./sq. cm./1°C./cm.	7.1-7.4	–	–	–	12	–
18. Specific heat, cal. per °C. per gm.	–	–	–	–	0.23-0.26	–
19. Thermal expansion, D696, 10^{-5} per °C.	1.0-1.2	–	0.7-2.5	–	0.7-1.2	–
20. Resistance to heat (continuous),[b] °F.	250-360	210-260	210-260	225-275	300	290
21. Heat distortion temp., D648, °F.	355-375	–	–	–	–	–
22. Insulation resistance (96 hr. at 90% R.H. and 35°C.), D257, megohms	50000-100000	–	100-5000	5	30-1500	10
23. Volume resistivity (50% R.H. and 25°C.), D257, ohm-cm.	–	–	–	–	–	–
24. Dielectric strength, short-time, 1/8-in. thickness, D149, volts per mil	400-750	400-700	200-450	50-150	200-500	300-450
25. Dielectric strength, step-by-step, 1/8-in. thickness, D149, volts per mil	300-600	200-450	150-350	60-120	150-350	250-350
26. Dielectric strength, step-by-step, ‖ to lamination, KV/in.	35-110	–	12-50	7	15-75	35-55
27. Dielectric constant, 60 cycles, D150	4.2-6.5	–	7.5-8.6	–	6.5-10.0	4.5-6.5
28. Dielectric constant, 10^3 cycles, D150	–	7.9	7.3-8.3	–	6.1-9.5	4.2-6.0
29. Dielectric constant, 10^6 cycles, D150	4.5-5.3	6.4-8.5	6.2-8.0	8.0-9.6	6.0-9.0	4.2-6.8
30. Dissipation factor, 60 cycles, D150	0.003-0.015	–	0.06-0.15	–	0.04-0.10	0.004-0.05
31. Dissipation factor, 10^3 cycles, D150	–	0.057	0.03-0.09	–	0.012-0.03	0.004-0.05
32. Dissipation factor, 10^6 cycles, D150	0.015-0.025	0.035-0.05	0.03-0.07	0.12-0.22	0.011-0.025	0.006-0.08
33. Arc resistance, D495, sec.	15-130	100	120-135	–	175-200	170-200
34. Water absorption, 24 hr., 1/8-in. thickness, D570, %	0.05-0.25	1.0-2.0	1.0-2.0	1.0-5	1.0-2.5	1.25-2.8
35. Burning rate, D635	Slow	Approximately nil			Nil	Nil
36. Effect of sunlight	Slight color change	Slight color change				–
37. Effect of weak acids, D543	None	Slight to marked	Slight to marked	None	None	None
38. Effect of strong acids, D543	Slight	Decomposes				
39. Effect of weak alkalies, D543	None	None	None	None	None	None
40. Effect of strong alkalies, D543	Slight	Attacked	Attacked	None	Attacked	Attacked
41. Effect of organic solvents, D543	None	None on bleed-proof materials				
42. Machining qualities	Good	Fair	Fair	Fair	Fair	Fair
43. Trade designations (see list of manufacturers opposite for key to numbers)	Dilecto (7), Formica (14), Gilfab (16), Helix (1), Norplex (25), Phenolite (24), Renite (41), Sunform (9), Synthane (35), Taylor (36), Textolite (15), Trevarno (4)	Aqualite (24), Celoron (7), Consoweld (5), Decarlite (8), Dilecto (7), Farlite (12), Formica (14), Hi-Den (27), Insurok (29), Lamicoid (22), Lamin-Art (11), Micarta (37), Nevamar (23), Norplex (25), Ohmoid (38), Panelyte (26), Phenolite (24), Pionite (28), Pregwood (14), Resilyte (2), Richelain (29), Ryertex (32), Spauldite (34), Synthane (35), Taylor (36), Tensilite (19), Textolite (15)				
44. Manufacturers (See list opposite for key to numbers)	1, 4, 7, 9, 10, 14, 15, 16, 24, 25, 35, 36, 40, 41	2, 3, 5, 7, 8, 11, 12, 14, 15, 18, 19, 22, 23, 24, 25, 26, 27, 28, 29, 32, 34, 35, 36, 37, 38				

	TEFLON LAMINATES		SILICONE LAMINATES		LIGNIN PLASTIC
	Ceramic fiber base	*Glass fabric base*	*Glass fabric base*	*Asbestos fabric base*	*(Laminated)*
1.	–	–	430-480	350-400	275-365
2.	–	–	30-2000	30-2000	2000-25000
3.	1.9-2.2	2.2	1.6-1.9	1.75	1.35-1.45
4.	14.6-12.8	12.8	17.3-14.5	15.8	21.6-19.0
5.	1500-4000	12000-20000	10000-30000	–	5000-8000
6.	–	–	15-20	–	–
7.	–	20000	35000-46000	40000-50000	25000-30000
8.	–	–	–	–	–
9.	–	11000-13000	10000-30000	12000-16000	9000-15000
10.	–	–	10-25	–	13
11.	–	11000	16500-18000	–	–
12.	–	–	–	–	–
13.	–	–	–	–	–
14.	1.1-2.5	5-6	8-15	6-9	0.5-1.5
15.	–	600-900	600-1300	–	450-600
16.	–	M60	M100	–	M90
17.	–	1-2	7	–	–
18.	0.25	0.2	0.25-0.27	–	–
19.	3.7-3.8	–	0.5-1.0	–	0.42
20.	500	480	400-500	>480	150
21.	>500	–	500	>400	–
22.	30	5000 to 10^6	1-300000	–	–
23.	$>10^7$	$>10^6$	–	–	1.6×10^{12}
24.	150-250	300-750	200-480	50-150	135 (¼ in.)
25.	–	250-700	150-350	50-100	105 (¼ in.)
26.	–	50-70	25-55	–	–
27.	2.5-2.7	2.6-2.8	3.7-4.3	–	6 (¼ in.)
28.	–	2.6-2.8	3.7-4.3	–	–
29.	2.4-2.5	2.6-2.8	3.7-4.3	–	–
30.	0.002-0.003	0.0005	0.0005-0.0055	–	0.11
31.	–	0.0004	0.0006-0.0035	–	–
32.	0.001-0.003	0.0006	0.0015-0.003	–	–
33.	190	180	150-250	–	135
34.	0.5-2.0	0.02	0.15-0.65	1.0-1.5	2.5 (¼ in.)
35.	Nil	Nil	Very low	Nil	Slow
36.	Nil	Nil	Nil	Nil	Slight
37.	None	None	None	Very slight	None to slight
38.	Attacked by HF only		Some attack	Some attack	Poor
39.	None	None	Very slight	Very slight	Fair
40.	Slight	Slight	Attacked	Attacked	Poor
41.	None	None	Attacked by some		Slight
42.	Fair to good	Good	Fair	Fair	Good
43.	Duroid (30)	–	Dilecto (7), Formica (14), Gilfab (16), Lamicoid (22), Micarta (37), Panelyte (26), Phenolite (24), Sunform (9), Synthane (35), Taylor (36), Textolite (15), Trevarno (4)		Benelex (21)
44.	30	7	4, 7, 9, 10, 14, 15, 16, 20, 22, 24, 26, 35, 36, 37, 40		21

LIST OF MANUFACTURERS AND SUPPLIERS*

1. Biggs Co., Inc., Carl H., 2255 Barry Ave., Los Angeles 64, Calif.
2. Buckstaff Co., The, Oshkosh, Wis.
3. Capac Industries, Inc., S. Main St., Capac, Mich.
4. Coast Mfg. and Supply Co., Livermore, Calif.
5. Consoweld Corp., Wisconsin Rapids, Wis.
6. Continental Can Co., Inc., 4300 N. Port Washington Rd., Milwaukee, Wis.
7. Continental-Diamond Fibre Co., Newark, Del.
8. Decar Plastic Corp., Middleton, Wis.
9. Electro-Technical Products, Div. of Sun Chemical Corp., 113 E. Centre St., Nutley 10, N.J.
10. Emerson and Cuming, Inc., 869 Washington St., Canton, Mass.
11. Fabricon Products, Div. of Eagle-Picher Co., 1721 Pleasant Ave., River Rouge 18, Mich.; 6430 E. Slauson, Los Angeles, Calif.
12. Farley & Loetscher Mfg. Co., Dubuque, Iowa
13. Flexfirm Products, 2300 North Chico Ave., El Monte, Calif.
14. Formica Corp., The, 4614 Spring Grove Ave., Cincinnati 32, Ohio
15. General Electric Co., Coshocton, Ohio
16. Gill Corp., M.C., 1422 Potrero, El Monte, Calif.
17. Glastic Corporation, 1823 E. 40th St., Cleveland 3, Ohio
18. Haskelite Mfg. Corp., Grand Rapids 2, Mich.
19. J.P. Lewis Co., Beaver Falls, N.Y.
20. Lunn Industries, Inc., Oakwood Rd. & W. 11th St., Huntington Station, L.I., N.Y.
21. Masonite Corporation, 111 West Washington St., Chicago, Ill.
22. Mica Insulator Co., P.O. Box 1076, Schenectady 1, N.Y.
23. National Plastic Products Co., Odenton, Md.
24. National Vulcanized Fibre Co., Wilmington 99, Del.
25. Northern Plastics Corp., La Crosse, Wis.
26. Panelyte Div., St. Regis Paper Co., Enterprise Ave., Trenton, N.J.
27. Parkwood Laminates, Inc., 24 Water St., Wakefield, Mass.
28. Pioneer Plastics Corp., 28 Goodhue St., Salem, Mass.
29. Richardson Co., The, 2747 Lake St., Melrose Park, Ill.
30. Rogers Corp., Rogers, Conn.
31. Russell Reinforced Plastics Corp., 4 S. 13th St., Lindenhurst, L.I., N.Y.
32. Joseph T. Ryerson & Son, Inc., P.O. Box 8000-A, Chicago 80, Ill.
34. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N.Y.
35. Synthane Corp., Oaks, Pa.
36. Taylor Fibre Co., Norristown, Pa.; La Verne, Calif.
37. Westinghouse Electric Corp., P.O. Box 868, Pittsburgh 30, Pa.
38. Wilmington Fibre Specialty Co., New Castle, Del.
39. Woodall Industries, Inc., 7565 E. McNichols Road, Detroit 34, Mich.
40. Zenith Plastics Co., 1600 West 135th St., Gardena, Calif.
41. Ren Plastics, Inc., 3179 S. Cedar Rd., Lansing 4, Mich.

*The values for the properties in this chart are based upon maximum and minimum figures submitted by a number of manufacturers of each type of laminate. The manufacturers should always be consulted before making a choice of laminate.

[a] D numbers refer to A.S.T.M. methods.

[b] The values reported for this property depend on the size and shape of the test piece and the molding conditions. The maximum permissible service temperature will vary with the formulation of the material, design of the part, and service conditions such as amount of stressing, humidity, etc. Requirements for resistance to heat should be considered a special problem.

Low-Pressure Laminating Resins Chart

PROPERTY	SHERWIN-WILLIAMS CO., PC&C Division, 260 Madison Ave., New York 16, N.Y.						ALKYDOL LABORATORIES, INC. Chicago 50, Ill.	TECHNICRAFT CO. 1156 Commonwealth Ave., Boston 34, Mass.
Resin number	XFR-10	XFR-11	AA 5289	AA 4540	AA 4544	AA 4545	Alk-O-Flex 452	Chemiglas Casting, embedding
Identity	Rigid; general-purpose polyester	Rigid; general-purpose polyester	Flexible polyester	Fire-retardant polyester	Rigid; light-stable polyester	Non-air-inhibited polyester	Epoxy resin	Styrene polyester resin
Viscosity at 25 °C., cp.	500–885	1760–2270	100–150	320–400	500–885	500–885	9850	Adjustable
Storage life of resin	No catalyst, in dark: 40 °F.: over 1 yr. 77 °F.: over 4 mo.						–	No catalyst 40 °F.: >1 yr. 77 °F.: >9 mo. (in container)
Resin content as applied, %	66–68	66–68	66–68	66–68	66–68	66–68	–	50–75
Storage life of treated material	1% benzoyl peroxide at 77 °F. and in dark: 4 to 6 days						–	1% catalyst: 10 hr.
Curing cycle Pressure, p.s.i.	Contact and up						0–75 and up	Contact to 200
Temperature, °F.	Room temperature to 260, depending on the catalyst system and amount of resin						–	–
Time, min.	Heat cure: 1 to 30 depending on the catalyst system and amount of resin. Room temperature cure: 5 min. to several hours depending upon conditions.						–	24–48 hr. with 1% cat.; 30–40 min. with 1% cat. & promoter; 10 min. with 1% C & P plus infra-red or ultra-violet (small castings)

PROPERTY	GENERAL ELECTRIC COMPANY, 1 Plastics Avenue, Pittsfield, Mass. (see also p. 597)						EMERSON AND CUMING, INC. Canton, Mass.
Resin number	AR401	AR403	AR480	AR493	AR501	AR499	Ecco L 65. Low elec. loss
Identity	Unsaturated polyester resin						Cross-linked styrene
Viscosity at 25 °C., cp.	3,000–4,000 non-adjustable	1,700–2,700 adjustable	600–1,000 adjustable	1,700–2,700 adjustable	200–300 adjustable	600–900 adjustable	–
Storage life of resin	No catalyst, refrigerated: indefinitely No catalyst, room temperature: 4 mo. (min.)					Refrigerated: 6 mo. at 77 °F. In absence of light: 3 mo.	–
Resin content as applied, %	30 to 80						
Storage life of treated material	With 1% benzoyl peroxide 4 days at room temperature					At 77 °F.: 4 mo.	–
Curing cycle Pressure, p.s.i.	Contact to 300 (or beyond if desired)						Contact and up
Temperature, °F.	Matched-die molding and laminating: 230–260. Also room temperature cure with accelerators.					250–300	150–250
Time, min.	Heat cure: 1–30 depending upon temperature and conditions. Room temperature cure: 5 min. to several hours depending upon conditions					1–30	150 °F.: 4 hr. 250 °F.: 1 hr.

PROPERTY	THE GLIDDEN COMPANY, 11001 Madison Ave., Cleveland 2, Ohio						Silicones Div., Union Carbide and Carbon Corp., New York 17, N.Y.
Resin number	Glidpol 1001, 1005, 1012. General purpose; variable-reactivity; rigid.	Glidpol 1019, 1020. Semi-rigid, resilient	Glidpol 1017. High heat distortion; rigid.	Glidpol 1018. Fire retardant; rigid.	Glidpol 2002. Flexible.	Glidpol 4000 Series. Coating resins at 100% reactivity.	Union Carbide R-63
Identity	Unsaturated polyester resin						Silicone
Viscosity at 25 °C., cp.	600–1000	800–2200	1500	1700	100	50–2000	30–50
Storage life of resin	4 to 6 months at 77 °F.						Room temp.: >6 mo.
Resin content as applied, %	65 to 75					50 to 100	60
Storage life of treated material	2 hours to 5 days depending on catalyst used.						Catalyzed: 1–2 days.
Curing cycle Pressure, p.s.i.	Contact pressure to 800					Capable of air dry in 4 hr. Cured at elevated temperatures (200–300 °F.) in 2 to 15 min.	1000 lb.
Temperature, °F.	Room temperature to 260, depending on resin and catalysts.						340–480
Time, min.	2–5, depending on temperature, catalysts, and resin mass.						½ to 2 hr.; post-baked if cured at <400 °F.

PROPERTY	AMERICAN CYANAMID CO., 30 Rockefeller Plaza, New York 20, N.Y.						ATLAS POWDER COMPANY Wilmington 99, Del.	
Resin number	Laminac 4101, 4109, 4110, 4111, 4116, 4119, 4120, 4123, 4128. General purpose	Laminac 4134. Flexible	Laminac 4146. Fire-resistant	Laminac 4190 Series. Light stabilized	Laminac 4202. Non-volatile	Laminac 4232 4233. High heat resistant	Atlac 382. Chemical resistant	Atlac FP. Fire-resistant
Identity	Styrene modified polyesters				Diallyl phthalate modified	Triallyl cyanurate modified	Unsaturated polyester resin (solid)	
Viscosity at 25°C., cp.	200-25,000	250-275	350-400	150-300	120,000-150,000		In 35% styrene: 8000. In 50% styrene: 500	In 30% styrene: 4000
Storage life of resin	Greater than 3 months at 77°F.						Indefinite	
Resin content as applied, %	100% reactive						100 (as supplied)	
Storage life of treated material	From hours to days depending on catalyst formulation, type of resin and temperature of storage						Room temperature: 1 day up to 6 mo.	
Curing cycle Pressure, p.s.i.	From contact to 1000 or higher						Contact to 100	
Temperature, °F.	Room temperature to 275, depending upon catalyst and promoter used.				200-300	180-500	Room to 320, depending on catalyst	
Time	From 1 to 30 min. at oven temperatures to several hr. at room temperature				From 10 min. to several hours		1 min. up to 30 min., depending on conditions	

PROPERTY	SPECIALTY RESINS CO., 2801 Lynwood Road, Lynwood, Calif.					COLUMBIA-SOUTHERN CHEMICAL CORP., 1 Gateway Center, Pittsburgh 22, Pa.	AMERICAN REINFORCED PLASTICS SALES, 650 S. Spring St., Los Angeles 14, Calif.
Resin number	DurOpol 104	DurOpol 109	DurOpol 120	DurOpol 190	DurOpol 2894 CW Cold cure resin	Allyl diglycol carbonate	CTL-91-LD
Identity	Polyester-styrene	Polyester-styrene	Polyester-styrene	Polyester-styrene	Polyester-styrene	Allyl resin	Phenolic
Viscosity at 25°C., cp.	2500-3200	900-1300	800-1200	1750-2300	600-800	19.5 at 25°C. 6.4 at 70°C.	Can be adjusted
Storage life of resin	70°F., dark: >3 mo.; 105°F., dark: 14 days	75°F., dark: >4 mo.; 105°F., dark: 14 days	75°F., dark: >4 mo.; 105°F., dark: 14 days	70°F., dark: >3 mo.; 105°F., dark: 14 days	70°F., dark: >3 mo.; 105°F., dark: 14 days	No catalyst: several months; with catalyst: approx. 2 wk.	Must be refrigerated
Resin content as applied, %	–	–	–	–	–	40	35-40
Storage life of treated material	70°F.: 36 hr. 100°F.: 6 hr. (1% benzoyl peroxide)	75°F.: 24 hr. 105°F.: 10 hr. (1% benzoyl peroxide)	75°F.: 30 hr. 100°F.: 15 hr. (1% benzoyl peroxide)	70°F.: 36 hr. 100°F.: 6 hr. (1% benzoyl peroxide)	–	Room temp.: approx. 2 wk.	Room temp.: 1 mo. to indefinite. Refrigerated: indefinite
Curing cycle Pressure, p.s.i.	Contact and up	Contact and up	Contact and up	Contact and up	Contact and up	1-5	70 and up, or vacuum
Temperature, °F.	Room temperature to 275, depending upon catalyst and promoter used.					Start at 158. Raise slowly to 238.	260 plus postcure
Time, min.	1/16": 2 1/8": 4 1/4": 8 (at 50 p.s.i.)	1/8": 15-20 1/4": 30-40 1/2": 45-55 (at 30 p.s.i.)	1/8": 20-30 1/4": 40-50 1/2": 60-70 (at 30 p.s.i.)	1/8": 15-20 1/4": 30-45 1/2": 45-75 (contact to 50 p.s.i.)	Depends on temp. and amount of catalyst.	1/8": 4-6 hr. 1/2": 6-8 hr.	45 plus postcure

PROPERTY	CELANESE CORPORATION OF AMERICA, Plastics Div., 290 Ferry St., Newark 5, N.J.										
Resin number	MR-28V MR-28C MR-28H	MR-28VS MR-28CS	MR-30V MR-30C	MR-31V MR-31C	Marcothix Resins	MR-33V MR-33C MR-33H	MR-36R	MR-37C	MR-40R	MR-41R	MR-42R
Identity	Unsaturated polyester resin										
Viscosity at 25°C., cp.	V: 50 C: 600 H: 8,000	VS: 50 CS: 600	V: 30 C: 300	V: 50 C: 600	Thixotropic	V: 600 C: 2,000 H: 35,000	2000	600	2000	2000	2000
Storage life of resin	No catalyst, 70°F.: 6 mo.						No catalyst, 70°F.: 3 mo.				
Resin content as applied, %	47-85								70		
Storage life of treated material	40°F.: 1-2 wk. 70°F.: 4-6 da.	40°F.: 3-4 wk. 70°F.: 1-2 wk.	40°F.: 1-2 wk. 70°F.: 4-6 da.	40°F.: 3-4 wk. 70°F.: 1-2 da.	40°F.: 1-2 wk. 70°F.: 4-6 da.	40°F.: 3-4 wk. 70°F.: 1-2 wk.	40°F.: 2-3 wk. 70°F.: 3-5 da.	40°F.: 2-3 wk. 70°F.: 3-5 da.	40°F.: 1-2 wk. 70°F.: 3-5 da.		
Curing cycle Pressure, p.s.i.	Contact to 100								Contact to 500		
Temperature, °F.	200-320 depending on catalyst. Room temperature curing with Marco Accelerators D and E.										
Time, min.	1 to 30, depending on catalyst, temperature, and pressure.										

PROPERTY	INTERCHEMICAL CORPORATION FINISHES DIVISION, 1754 Dana Avenue, Cincinnati 7, Ohio								
Resin number	IC-312	IC-336	IC-382	IC-401	IC-433	IC-766	IC-625	IC-636	IC-638
Identity	Standard general-purpose	HV rigid, stain resistant	HHDT rigid	Flexible	Resilient, high-impact	Rigid, fast cure	Rigid, chemical-resistant	FR Polyester	Rigid, non-volatile
Viscosity at 25°C., cp.	2100-2700	45,000-75,000	2100-2700	300	420-500	600-700	2100-2700	2100-2700	45,000
Storage life of resin	60°F.: 9-12 mo.; 75°F.: 4-6 mo.; 85°F.: 2-3 mo.								
Monomer, %	Styrene 30	Styrene 22	Styrene 30	Styrene 30	Styrene 30	Styrene 35	Styrene 30	Styrene 25	DAP
Storage life of treated material	Catalyzed with 1% benzoyl peroxide: Room temperature: 3-5 days; at 100°F., >24 hr.								
Curing cycle Pressure, p.s.i.	0 to 500								
Temperature, °F.	Room temperature to 250, depending on the catalyst system and amount of resin								
Time, min.	1 to 30, depending on temperature, catalyst system, and amount of resin.								

PROPERTY	INTERCHEMICAL CORPORATION FINISHES DIVISION, 1754 Dana Avenue, Cincinnati 7, Ohio					CIBA COMPANY, INC., Plastics Div., Kimberton, Pa.	
Resin number	IC-671	IC-947	IC-730	IC-970	IC-990	Araldite 6005, 6010, 6020, 6071, 6075	Araldite 502, 6005, 6010, 6020
Identity	Rigid, fast cure	Resilient, non-volatile	Resilient polyester	Wax resin	Resilient, high tensile, good hot strength	Epoxy resins	Epoxy resins
Viscosity at 25°C., cp.	8,000-11,000	60,000	900-1100	Solid	2400	Can be adjusted to suit	2,500-25,000
Storage life of resin	60°F.: 9-12 mo.; 75°F.: 4-6 mo.; 85°F.: 2-3 mo.					At least one year	At least one year
Monomer, %	Vinyltoluene 30	DAP	Styrene 30	None	Styrene 30	30-35	30-35
Storage life of treated material	Catalyzed with 1% benzoyl peroxide: Room temperature: 3-5 days; at 100°F., >24 hr.					Dicyandiamide: unlimited at room temp. Methylenedianiline: 2-3 wk. at room temp.; 6 mo. at 40°F. Diaminodiphenyl sulfone: 3 mo. at room temp.	Depends on curing agent
Curing cycle Pressure, p.s.i.	0 to 500					Contact and up	Contact and up
Temperature, °F.	Room temperature to 250, depending on the catalyst system and amount of resin					Dicyandiamide: 345 Methylenedianiline: 300 Diaminodiphenyl sulfone: 300	60-350
Time, min.	1 to 30, depending on temperature, catalyst system, and amount of resin.					Dicyandiamide: 30 Methylenedianiline: 5-30 Diaminodiphenyl sulfone: 60 (with accelerator)	10-60

PROPERTY	MOL-REZ DIVISION, American Petrochemical Corp., 3134 California St., N.E., Minneapolis 18, Minn.					
Resin number	Pleogen 1000-1100 Rigid, general purpose, hand layup	Pleogen 1006 Rigid, general purpose, hand layup, medium viscosity	Pleogen 1200 Casting resin	Pleogen 1300 Rigid-laminating resin	Pleogen 1402-1406 Flexible-for impact strength	Pleogen 1150 Resilient, general purpose, hand layup
Identity	Polyester-styrene					
Viscosity at 25°C., cp.	330-380	550-650	2000	2000-2500	200-450	650-850
Storage life of resin	Several months in dark					
Monomer, %	35	33	27	27	33	33
Storage life of treated material	2-5 days in dark, when catalyzed with benzoyl peroxide					
Curing cycle Pressure, p.s.i.	Contact to 300					
Temperature, °F.	Room to 250, depending on catalyst					
Time, min.	2 min. to 48 hr. depending on catalyst system used					

PROPERTY	MOL-REZ DIVISION, American Petrochemical Corp., 3134 California St., N.E., Minneapolis 18, Minn.					
Resin number	Pleogen 1501 For matched metal die molding	Pleogen 1700 Rigid, high-viscosity overlay resin	Pleogen 1800 Highly thixotropic rigid resin	Pleogen 1813 Semi-thixotropic rigid resin	Pleogen 1850 Highly thixotropic resilient resin	Pleogen 2001 Translucent gel coat
Identity	Polyester-styrene					
Viscosity at 25°C., cp.	2000-2500	45,000-75,000	Grease-like	About 1000	Grease-like	Very heavy
Storage life of resin	Several months in dark					
Monomer, %	27	18	38	36	35	—
Storage life of treated material	2-5 days in dark, when catalyzed with benzoyl peroxide					
Curing cycle Pressure, p.s.i.	Contact to 300					
Temperature, °F.	Room to 250, depending on catalyst					
Time, min.	2 min. to 48 hr. depending on catalyst system used					

PROPERTY	H. H. ROBERTSON CO., 2407 Farmers Bank Bldg., Pittsburgh 22, Pa.							LOVEN CHEMICAL OF CALIFORNIA, Newhall, Calif.
Resin number	Stypol 16B	Stypol 25	Stypol 4051	Stypol 407	Stypol 405	Stypol 100S	Stypol 12	Loven LLR 26044
Identity	VHHDT rigid polyester	VHHDT rigid polyester	Resilient polyester	HHDT rigid polyester	Rigid polyester	Light stabilized rigid polyester	Flexible polyester	Phenolic resin
Viscosity at 25°C., cp.	10,000-20,000	3000-5000	1500-1800	1500-1800	900-1200	2000-2500	600-900	300-500
Storage life of resin	77°F.: >3 mo. 40°F.: >1 yr.							Room temp.: 2 mo. <60°F.: 5 mo.
Resin content as applied, %	30 to 60							30-50
Storage life of treated material	77°F.: 5 days, except Stypol 114 which is 2-3 days. 100°F.: several hr.							<70°F.: 6 mo.
Curing cycle Pressure, p.s.i.	Contact to 100							Contact and up
Temperature, °F.	180 to 250, depending on catalyst. Room temperature cure possible with promoters. For best properties, low temperature gelation, followed by elevated temperature postcure							300-350 on one side
Time, min.	1/8": 3-30, depending on temperature and catalyst							3-15, depending on conditions

PROPERTY	BRITISH RESIN PRODUCTS LIMITED Devonshire House, Piccadilly, London, W.1., England										
Resin number	Cellobond A.262 Rigid, general-purpose	Cellobond A.264 Rigid, general-purpose	Cellobond AX.2623 Rigid, general-purpose	Cellobond AX.2652 Rigid, general-purpose	Cellobond AX.2660 Rigid, heat resistant	Cellobond AX.2530 Rigid, transparent roofing sheet	Cellobond AX.2531 Rigid, transparent roofing sheet	Cellobond A.250 Rigid, chemical resistant	Cellobond AX.2571 Rigid, chemical resistant	Cellobond AX.2572 Rigid, chemical resistant	Cellobond AX.2590 Flexible plasticizing resin
Identity	Polyester/styrene										Polyester
Viscosity at 25°C., cp.	800-1200	1400-1900	500-800	–	800-1200	240-320	80-125	1900-2600	100-200	100-200	20,000-25,000
Storage life of resin	6-9 mo. at 77°F., sealed, in the dark										>12 mo. at 77°F., sealed, in dark
Resin content as applied, %	70	73	65	65	65	70	55	70	60	60	100
Storage life of treated material	About 5 days with 1% benzoyl peroxide About 2 days with 1% MEK peroxide or HCH										
Curing cycle Pressure, p.s.i.	Contact to 300										
Temperature, °F.	Room to 250, depending on catalyst										
Time, min.	Hot curing: 3-15 min. Cold curing: ½-6 hr.										

PROPERTY	BRITISH RESIN PRODUCTS LIMITED, Devonshire House, Piccadilly, London, W.1, England					THE GENERAL TIRE AND RUBBER CO., Chemical Div., Akron 9, Ohio		
Resin number	Cellobond AX.2591 Flexible plasticizing resin	Cellobond A.263 Export version of A.262	Cellobond AX.2540 Export version of AX. 2530	Cellobond A.251 Export version of A.250	Cellobond AX.2601 Preforms	Glykon R-300. Rigid	Glykon F-700. Flexible	Glykon R-312. Resilient
Identity	Polyester/ styrene	Polyester (styrene monomer free)			Polyester emulsion	Polyesters		
Viscosity at 25°C., cp.	300-600	1150-1500 (70% sol.)	260-340 (70% sol.)	2600-3600 (70% sol.)	–	2000	65 (50% in styrene)	2250
Storage life of resin	>12 mo. at 77°F., sealed, in the dark				3 mo. at 77°F., sealed, in the dark	6 mo.	12 mo.	6 mo.
Resin content as applied, %	70	70	70	70	50	70	100	70
Storage life of treated material	About 5 days with 1% benzoyl peroxide About 2 days with 1% MEK peroxide or HCH				A few days	2-3 days at 77°F. (dark)		
Curing cycle Pressure, p.s.i.	Contact to 300				Nil	Contact and up		
Temperature, °F.	Room to 250, depending on catalyst				Hot air drying	Room temperature and up depending on conditions		
Time, min.	Hot curing: 3-15 Cold curing: ½-6 hr.				Related to drying conditions	1 min. and up depending on conditions		

PLASTICS					PROCESSING QUALITIES						
					Molding Qualities	Compression Molding Temperature, ° F.	Compression Molding Pressure, p.s.i.	Injection Molding Temperature, ° F.	Injection Molding Pressure, p.s.i.	Compression Ratio	
A.S.T.M. TEST METHOD →					–	–	–	–	–	–	
					P-Poor F-Fair G-Good Exc.-Excellent	200 300 400 500	0 2,000 4,000 6,000 8,000 10,000	200 400 600	10,000 20,000 30,000 40,000	1 4 7 10	C=C I=In 0
PHENOL-FORMALDEHYDE AND PHENOL-FURFURAL COMPOUNDS	MOLDING	No filler		1	F	270-320	2000-5000	–	–	2.0-2.5	0.
		Woodflour and cotton flock filler		2	Exc.	290-380	1500-5000	–	–	2.1-4.4	0.
		Asbestos filler		3	G to F	270-380	500-6000	–	–	2.0-14	0.0
		Mica filler		4	G to F	280-350	2000-5500	–	–	2.1-2.7	0.0
		Glass fiber filler		5	G	280-350	1000-5000	–	–	6.1	0.0
		Macerated fabric and cord filler		6	G to F	280-380	2000-6500	–	–	3.5-18.0	0.
		Pulp preformed and molding board		7	G	290-350	2000-5000	–	–	1.5-3.5	0.0
		Compounded with butadiene-acrylonitrile copolymer	Woodflour and cotton flock filler	8	F to G	300-360	2000-6000	–	–	2-4	0.
			Asbestos filler	9	F to G	310-360	2000-6000	–	–	2.5	0.
			Rag filler	10	F to G	310-360	2000-6000	–	–	4.6-8	0.
	CAST	No filler		11	–	–	–	–	–	–	
		Mineral filler		12	–	–	–	–	–	–	
		Asbestos filler		13	–	–	–	–	–	–	
	Casting resin, mechanical grade			14	–	–	–	–	–	–	
Furan Molding Compounds (Asbestos filler)				15	G	275-300	100-500	–	–	–	
Urea-formaldehyde Molding Compound (Alpha-cellulose filler)				16	Exc.	275-350	2000-8000	–	–	2.2-3.0	0.
MELAMINE-FORMALDEHYDE MOLDING COMPOUNDS	No filler			17	G	300-330	2000-5000	–	–	2.0	0.
	Alpha cellulose filler			18	Exc.	280-370	1500-8000	–	–	2.1-3.1	0.
	Cellulose filler			19	G	290-360	1500-6000	–	–	2.2-2.5	0.
	Flock filler			20	G	275-330	4000-8000	–	–	4-7	0.
	Asbestos filler			21	G	280-340	1000-7000	–	–	2.1-2.5	0.
	Macerated fabric filler			22	G	275-330	4000-8000	–	–	5-10	0.
	Macerated fabric filler (phenolic modified)			23	G	300-350	4000-8000	–	–	5-10	0.
	Glass fiber filler			24	G	280-340	3000-6000	–	–	–	0.
Epoxy Cast Resin (No filler)				25	–	–	–	–	–	–	0.
Polysulfide Epoxy Casting Resins				26	–	–	–	–	–	–	0.
SILICONE MOLDING COMPOUND	Asbestos filler			27	G	300-350	1000-5000	–	–	6-8	
	Mineral filler			28	F	300-350	2000-6000	–	–	2.1-2.8	0.
	Glass fiber filler			29	F	300-350	1000-5000	–	5000-10000	6-9	
CELLULOSIC MOLDING COMPOUNDS AND	Ethyl cellulose molding compounds and sheets			30	Exc.	250-390	500-5000	350-500	8000-32000	1.8-2.4	0.
	CELLULOSE ACETATE	Sheet		31	Exc.	210-320	500-5000	–	–	–	See
		Molding and extrusion		32	Exc.	260-420	500-5000	335-490	8000-32000	2-2.6	See
	Cellulose acetate, high acetyl			33	Exc.	210-390	500-5000	355-480	8000-32000	2.0-2.6	See
	Cellulose propionate molding			34	Exc.	360-450	1000-5000	335-515	8000-32000	2.0-2.4	L=0

Plastics Properties Chart

		PHYSICAL PROPERTIES										
ssion lo	Mold Shrinkage, in./in.	Specific Gravity	Specific Volume, cu. in./lb.	Refractive Index, n_D	Tensile Strength, p.s.i.	Elongation, %	Modulus of Elasticity in Tension, 10^3 p.s.i.	Compressive Strength, p.s.i.	Flexural Strength, p.s.i.	Impact Strength, ft.-lb./in. of Notch (½ × ½ in. Notched Bar, Izod Test)	Hardness, Rockwell	Ther ductiv cal./ cm./1
	–	D792	D792	D542	D638, D651	D638	D638	D695	D790	D256	D735	C
7 10	C = Compression I = Injection 0 0.008 0.016 0.024 0.032	1 1.25 1.50 1.75 2 2.25	← 25 20 15 10	1.4 1.5 1.6 1.7	5,000 10,000 15,000 20,000	0 200 400 600	10 20 30 40 50	10,000 20,000 30,000 40,000 50,000	5,000 10,000 15,000 20,000	Log. 0.5 1 5 10		4
-2.5	0.010-0.012	1.25-1.30	22.2-21.3	1.5-1.7	7000-8000	1.0-1.5	7.5-10	10000-30000	12000-15000	0.20-0.36	M124-M128	
-4.4	0.004-0.009	1.32-1.45	20.9-17.8	–	6500-8500	0.4-0.8	8-12	22700-36000	8500-12000	0.24-0.60	M100-M120	
-14 →	0.0005-0.006	1.52-2.0	18.2-13.8	–	4000-9000	0.18-0.50	10-25	15000-35000	7000-15000	0.27-3.5	M95-M115	
-2.7	0.0005-0.005	1.75-1.92	15.8-14.3	–	5000-7000	0.13-0.5	30-50	15000-25000	8000-12000	0.30-0.38	M100-M110	
1	0.0001-0.001	1.75-1.95	15.8-14.1	–	5000-10000	0.2	33	17000-26000	10000-60000 →	10-50 →	M95-M100	
-18.0 →	0.002-0.009	1.36-1.43	20.4-19.4	–	3300-9000	0.37-0.57	9-13	15000-30000	8500-15000	0.75-8.0	M95-M120	
-3.5	0.0018-0.007	1.36-1.42	20.4-19.6	–	4300-12000	0.3-0.7	9-13	16000-35000	7000-18500	0.5-4.5	E60-E85	
-4	0.006-0.010	1.24-1.35	22.3-20.5	–	4500-9000	0.75-2.25	4.0-6.0	11000-20000	7000-12000	0.35-1.0	M37-M85	
.5	0.004-0.007	1.60-1.65	17.3-16.8	–	3500-4000	–	5.0-9.0	10000-20000	6000-8000	0.30-0.40	M50	
-8	0.002-0.005	1.30-1.32	21.3-21.0	–	3500-4000	–	3.5-6.0	10000-15000	6000-8000	2.0-2.3	M40-M55	
-	–	1.30-1.32	21.3-20.9	1.58-1.66	6000-9000	1.5-2.0	4-5	12000-15000	11000-17000	0.25-0.40	M93-M120	
-	–	1.68-1.70	16.5-16.3	–	4000-9000	–	–	29000-34000	9000-12000	0.35-0.50	M85-M120	
-	–	1.70	16.3	–	3000-6000	–	18.8	10500-12500	5000-8000	–	R110	
-	–	1.25-1.30	22.2-21.3	–	4000-7000	–	5-7	15000-20000	9000-14000	0.3-0.4	M70-M110	
-	–	1.75	15.8	–	3000-4500	–	15.8	10000-13000	6000-9000	–	R110	
-3.0	0.006-0.014	1.47-1.52	18.8-18.2	1.54-1.56	6000-13000	0.5-1.0	15	25000-35000	10000-16000	0.25-0.35	M115-M120	
0	0.011-0.012	1.48	18.7	–	–	–	–	40000-45000	11000-14000	–	–	
-3.1	0.006-0.015	1.47-1.52	18.8-18.2	–	7000-13000	0.6-0.9	13	25000-43000	10000-16000	0.24-0.35	M110-M125	
-2.5	0.006-0.008	1.45	19.1	–	5000-9000	0.6	11	33500	9000-11500	0.27-0.36	M115-M125	
-7	0.006-0.007	1.50-1.55	18.5-17.8	–	7000-9000	–	–	30000-35000	13000	0.4-0.45	–	
-2.5	0.005-0.007	1.70-2.00	16.3-13.8	–	5500-7000	0.30-0.45	16	30000	9000-11000	0.28-0.40	M110	
-10	0.003-0.004	1.5	18.5	–	9500-10500	0.6-0.8	16	30000-35000	12000-15000	0.6-1.0	M120	
-10	0.003-0.006	1.5	18.5	–	7000-10500	0.6	16	25000-30000	14000-17000	1.1-1.4	M115	
-	0.001-0.003	1.9-2.0	14.4-13.8	–	6000-10000	–	–	26000-32000	15000-23000	8.0-16.0	–	
-	0.001-0.004	1.11-1.23	24.9-22.5	–	4000-13000	–	4.5	15000-18000	14000-19000	0.2-0.45	M80-M100	
-	0.003-0.0144	1.15-1.25	24.8-22.2	–	1000-10000	0-100	0.01-3.5	1000-14000	1000-18000	2-10	–	
-8	–	1.6-1.9	17.3-14.4	–	28000-35000 →	–	25-30	–	30000-35000 →	–	–	
-2.8	0.005-0.010	1.65-2.0	16.8-13.8	–	2500-4300	–	–	16000-24000	6800-7700	0.25-0.38	M89	
-9	0-0.005	1.68-2.0	16.5-13.8	–	4000-5000	–	–	9000-15000	9000-14000	3-15	M45	
-2.4	0.005-0.009	1.09-1.17	25.5-23.6	1.47	2000-8000	5-40	1.0-3.0	10000-35000	4000-12000	2.0-8.0 0.3-1.7 @ -40° F.	R50-R115	
-	See footnote[1]	1.28-1.32	21.6-20.9	1.49-1.50	4500-8000	20-50	2.5-4	18000-25000	6000-10000	1.0-3.0	R95-R120	
-2.6	See footnote[1]	1.24-1.34	22.4-20.6	1.46-1.50	1900-8500	6-70	0.86-4.0	13000-36000	2000-16000	0.4-5.2	R35-R125	
-2.6	See footnote[1]	1.26-1.34	22.0-20.6	1.46-1.50	3000-11000	4-55	1.0-4.5	14000-36000	3500-13000	0.4-5.2	R65-R125	
-2.4	I=0.001-0.005;	1.18-1.24	23.4-22.7	1.47-1.48	2000-7000	45-60	0.6-1.5	7000-22000	3000-11000	0.5-11	R20-R115	5

roperties Chart – Modern Plastics Encyclopedia

Compressive Strength, p.s.i.	Flexural Strength, p.s.i.	Impact Strength, ft.-lb./in. of Notch (½ × ½ in. Notched Bar, Izod Test)	Hardness, Rockwell	THERMAL PROPERTIES: Thermal Conductivity, 10^{-4} cal./sec./sq. cm./1°C./cm.	Specific Heat, cal./°C./gm.	Thermal Expansion, Linear, 10^{-5}/°C.	Resistance to Heat, °F. (continuous)[5]	Heat Distortion Temp., °F.	Volume Resistivity, ohm-cm. (50% relative humidity and 23°C.)	Dielectric Strength, Short-time, ⅛-in. Thickness, volts/mil	Dielectric Strength, Step-by-step, ⅛-in. Thickness, volts/mil	Dielectric Constant, 60 cy
D695	D790	D256	D785	C177	—	D696	—	D648	D257	D149	D149	D1
10,000 20,000 30,000 40,000 50,000	5,000 10,000 15,000 20,000	Log. 0.5 1 5 10		4 8 12 16	0.2 0.4 0.6	5 10 15 20	200 300 400 500	200 400 600 800	Log 10^{10} 10^{11} 10^{12} 10^{13}	100 300 500 700	200 400 600	2 6
0000-30000	12000-15000	0.20-0.36	M124-M128	3-6	0.38-0.42	2.5-6.0	250	240-260	10^{11}-10^{13}	300-400	250-350	5-
2700-36000	8500-12000	0.24-0.60	M100-M120	4-7	0.35-0.40	3.0-4.5	300-350	260-340	10^{9}-10^{13}	200-425	100-375	5.0-
5000-35000	7000-15000	0.27-3.5	M95-M115	8-16	0.28-0.32	1.5-4	350-600	290-350	10^{10}-10^{12}	100-350	75-325	10-
5000-25000	8000-12000	0.30-0.38	M100-M110	10-14	0.28-0.32	1.9-2.6	250-300	230-350	10^{12}->10^{14}	300-460	250-390	4.7-
7000-26000	10000-60000	10-50	M95-M100	–	–	1.6	350-450	>600	7×10^{12}	140-370	120-270	7.
5000-30000	8500-15000	0.75-8.0	M95-M120	4-7	0.30-0.35	1-4	220-250	250-300	10^{11}-10^{12}	200-400	150-300	6.0-
6000-35000	7000-18500	0.5-4.5	E60-E85	4-7	0.34-0.36	3.0-4.5	300-400	260-340	10^{10}-10^{13}	250-550	200-450	5.0-
1000-20000	7000-12000	0.35-1.0	M37-M85	5	0.33	1.5-4.0	212	230-260	10^{10}-10^{11}	300-325	225-300	9-
0000-20000	6000-8000	0.30-0.40	M50	15	–	4.0	225	275	10^{11}	275-350	225-300	1
0000-15000	6000-8000	2.0-2.3	M40-M55	2.16	–	–	212	225-240	10^{11}	250-325	200-225	11.5-
2000-15000	11000-17000	0.25-0.40	M93-M120	3-5	0.3-0.4	6-8	160	165-175	10^{13}-10^{13}	350-400	250-300	6.5-
29000-34000	9000-12000	0.35-0.50	M85-M120	–	–	7.5	160	150-175	10^{9}-10^{12}	100-250	75-200	-
10500-12500	5000-8000	–	R110	8.4	0.3	3.3	300	–	–	–	–	-
15000-20000	9000-14000	0.3-0.4	M70-M110	3-5	0.3-0.4	8-11	250	240-260	–	–	–	-
10000-13000	6000-9000	–	R110	–	–	–	265-330	–	–	–	–	-
25000-35000	10000-16000	0.25-0.35	M115-M120	7-10	0.4	2.7	170	270-280	10^{13}-10^{13}	300-400	250-300	7.0-
40000-45000	11000-14000	–	–	–	–	–	210	298	–	–	–	-
25000-43000	10000-16000	0.24-0.35	M110-M125	7-10	–	4.0	210	400	10^{13}-10^{14}	300-400	250-300	7.9-
33500	9000-11500	0.27-0.36	M115-M125	6.5-8.5	–	4.5	250	266	–	350-400	250-350	6.2-
30000-35000	13000	0.4-0.45	–	–	–	–	250	–	–	300-330	–	-
30000	9000-11000	0.28-0.40	M110	13-17	–	2.0-4.5	250-400	265	2.4×10^{11}	350-400	320	6.4-
30000-35000	12000-15000	0.6-1.0	M120	10.6	–	2.8	250	310	10^{9}-10^{10}	250-350	200-300	7.6-
25000-30000	14000-17000	1.1-1.4	M115	10.1	–	2.8	250	375	–	130-370	–	10.5-
26000-32000	15000-23000	8.0-16.0	–	11.5	–	1.5	300-400	400	7.0×10^{11}	250-300	140	-
15000-18000	14000-19000	0.2-0.45	M80-M100	4-5	–	4.5-6.5	250-600	115-550	10^{13}-10^{17}	400-500	380	3.5-
1000-14000	1000-18000	2-10	–	–	–	2-10	250-300	150-250	$1.3\text{-}15 \times 10^{14}$	235-400	235-400	3-
–	30000-35000	–	–	–	–	–	–	–	–	–	–	-
16000-24000	6800-7700	0.25-0.38	M89	3.7-4.0	1-3	5.0-5.8	>480	340->500	3×10^{7}-7×10^{8}	370-400	320-400	4.0-
9000-15000	9000-14000	3-15	M45	3.7-4.0	1-3	0.8	>480	>500->900	10^{7}-10^{13}	185-200	125-300	4.0-
10000-35000	4000-12000	2.0-8.0 0.3-1.7 @ -40°F.	R50-R115	3.8-7	0.3-0.75	10-20	115-185	115-190	10^{13}-10^{14}	350-500	300-530	3.0-
18000-25000	6000-10000	1.0-3.0	R95-R120	4-8	0.3-0.5	10-15	140-220	130-160	10^{11}-10^{13}	250-300	–	5.3-
13000-36000	2000-16000	0.4-5.2	R35-R125	4-8	0.3-0.42	8-16	140-220	110-205	10^{10}-10^{13}	250-365	200-300	3.5-
14000-36000	3500-13000	0.4-5.2	R65-R125	4-8	0.3-0.42	8-16	150-220	120-210	10^{10}-10^{13}	250-365	200-300	3.5-
7000-22000	3000-11000	0.5-11	R20-R115	5.28-5.36	0.38-0.40	11-17	155-220	110-180	10^{13}-10^{15}	300-450	–	–
–	4000-9000	0.8-6.3	R30-R115	4-8	0.3-0.4	11-17	140-220	115-200	10^{10}-10^{13}	250-400	–	3.5-
7500-22000	1800-9300											

dia Issue, 1957 *

ELECTRICAL PROPERTIES											CHEMICAL		
	DIELECTRIC CONSTANT			DISSIPATION (POWER)				Water Absorption, 24 hr., ⅛-in. Thickness, %	Burning Rate	Effect of Sunlight	EFF		
	Dielectric Constant, 60 cycles	Dielectric Constant, 10^3 cycles	Dielectric Constant, 10^6 cycles	Dissipation (power) Factor, 60 cycles	Dissipation (power) Factor, 10^3 cycles	Dissipation (power) Factor, 10^6 cycles	Arc Resistance, sec.				Weak Acids	Strong Acids	Weak
	D150	D150	D150	D150	D150	D150	D495	D570	D635	—	D543	D543	D
				Log.	Log.	Log.	Log.		N-None SE-Self-extinguishing L-Low M-Medium F-Fast	Sl.-Slight Dark.-Darkening Dis.-Discoloration Mod.-Moderate Yel.-Yellowing	N-None; R-Resistant; Sl.-Slight; At. Dec.-Decomposes; Dis.-Discoloratio Organic; B-p-Bleed-proof; Ket.-Keto Hydrocarbons; Ali.-Aliphatic; Red.-		
	5-6.5	4.5-6.0	4.5-5.0	0.06-0.10	0.03-0.08	0.015-0.03	Tracks	0.1-0.2	Very L	Sl. dark. of surface			N
	5.0-9	4.4-9.3	4.0-7.0	0.05-0.30	0.04-0.20	0.03-0.07	Tracks	0.3-1.0	Very L	General darkening			
	10-75	6-60	5.0-7.0	0.25-0.50	0.25-0.50	0.10-0.50	Tracks	0.10-0.50	N	General darkening			
	4.7-7.5	4.4-7.0	4.2-5.2	0.01-0.07	0.007-0.05	0.005-0.04	Tracks	0.01-0.10	N	General darkening			
	7.1	6.9	4.6-6.6	0.03	0.02	0.02	4-150	0.1-1.2	N	General darkening			
	6.0-15	5.0-11	4.5-7.0	0.08-0.45	0.04-0.20	0.03-0.09	Tracks	0.4-1.75	Almost N	General darkening	N to Sl. (depending on acid)	Dec. by ox. acids; N to Sl. by red. and org. acids	Sli ma dep on al
	5.0-8.0	5.0-8.0	4.0-7.0	0.04-0.30	0.02-0.20	0.03-0.7	2-130	0.6-1.8	Very L to SE	General darkening			
	9-15	–	5	0.14-0.50	–	0.08-0.10	20	1-2	S	General darkening			
	15	–	5	0.15	–	0.010-0.15	20	0.25-0.5	Very S	General darkening			
	11.5-15	–	5-5.4	0.45-0.7	–	0.10-0.11	20	1-2	S	General darkening			
	6.5-7.5	5.5-6.0	4.0-5.5	0.10-0.15	0.01-0.05	0.04-0.05	200-250	0.3-0.4	Very S	Colors may fade			
	–	14-30	9-15	–	0.10-0.30	0.07-0.20	–	0.12-0.36	Almost N	Darkens	N to Sl.	At. by ox. acids	N
	–	–	–	–	–	–	–	–	Almost N	Sl. dark.	N to Sl.		N
	–	–	–	–	–	–	–	0.2-0.4	Very L	Darkens	N to Sl.		Sl. to
	–	–	–	–	–	–	–	0.01-0.2	S	None	N to Sl.		N
	7.0-9.5	7.0-7.5	6.4-6.9	0.035-0.040	0.025-0.035	0.028-0.032	100-150	0.4-0.8	Very L	None	N to Sl.	Dec. or surface at.	Sl. to
	–	–	–	–	–	–	100-145	0.3-0.5	SE	Colors may fade	None	–	N
	7.9-9.5	7.8-9.2	7.2-8.2	0.030-0.080	0.015-0.036	0.027-0.045	110-180	0.1-0.6	N	Sl. color change	None	Dec.	N
	6.2-7.6	6.0-7.5	4.7-7.0	0.019-0.033	0.013-0.034	0.032-0.060	95-135	0.34-0.80	N	Sl. color change	N to Sl.	Dec.	N
	–	–	–	–	–	–	110-150	0.16-0.3	N	Sl. color change	N to Sl.	Dec.	N
	6.4-10.2	9.0	6.1-6.7	0.07-0.17	0.07	0.041-0.050	120-140	0.08-0.14	N	Sl. color change	N to Sl.	Dec.	At. sli
	7.6-8.6	7.1-7.8	6.5-6.9	0.07-0.11	0.03-0.05	0.036	115-125	0.3-0.6	N	Sl. dis-coloration	None	Dec.	N
	10.5-15.5	7.9-9.7	6.1-6.7	0.10-0.16	0.10-0.16	0.050-0.065	115-170	0.2-1.3	Very L	Color darkens	None	Dec.	N
	–	–	–	–	–	–	180	0.3-0.6	N	Slight	None	Dec.	N
	3.5-5.0	3.5-4.5	3.3-4.0	0.002-0.010	0.002-0.020	0.030-0.050	45-120	0.08-0.13	S	None	None	At. by some	N
	3-6	3-5	3-6	0.010-0.040	0.012-0.050	0.018-0.090	50-180	0.27-0.5	S	None	None	At. by some	N
	–	–	–	–	–	–	–	–	N to S	None to Sl.	N to Sl.	Slight	N
	4.0-5.0	3.7-5.0	3.7-5.0	0.003-0.013	0.002-0.011	0.003-0.006	250-420	0.2-0.5	N to S	None to Sl.	N to Sl.	Slight	N
	4.0-5.0	3.7-4.9	3.6-4.6	0.005-0.0065	0.005-0.0075	0.004-0.0065	220-350	0.1	N to S	None to Sl.	N to Sl.	Slight	N
	3.0-4.2	3.0-4.1	2.8-3.9	0.005-0.020	0.002-0.020	0.010-0.060	150-200	0.8-1.8	S	Sl. (when stabilized)	Slight	Dec.	N
	5.3-5.8	5.0-6.0	4.0-5.5	0.02-0.03	0.025-0.04	0.04-0.06	180-200	2.0-4.5	S to SE	Slight	Slight	Dec.	Sl
	3.5-7.5	3.5-7.0	3.2-7.0	0.01-0.06	0.01-0.06	0.01-0.10	50-310	1.9-6.5	S to SE	Slight	Slight	Dec.	Sl
	3.5-7.5	3.5-7.0	3.2-7.0	0.01-0.06	0.01-0.06	0.01-0.10	50-310	1.3-3.1	S to SE	Slight	Slight	Dec.	Sl
	–	3.6-3.9	3.4-3.6	–	0.006-0.01	0.01-0.03	175-190	1.2-2.0	S	Slight	Slight	Dec.	Sl
	3.5-6.4	–	–	0.01-0.04	–	–	–	0.9-2.2	S	Slight	Slight	Dec.	Sl

Burning Rate	Effect of Sunlight	CHEMICAL RESISTANCE — EFFECT OF: Weak Acids	Strong Acids	Weak Alkalies	Strong Alkalies	Organic Solvents	Machining Qualities	Clarity	PLASTICS (Numbers link to plastics listed at far left of chart)
D635	—	D543	D543	D543	D543	D635	—	—	
one Self- nguishing ow edium ast	SL.-Slight Dark.-Darkening Dis.-Dis- coloration Mod.-Moderate Yel.-Yellowing	N-None; R-Resistant; Sl.-Slight; At.-Attacked; Sw.-Swells; Dark.-Darkening; Dec.-Decomposes; Dis.-Discoloration; Sol-Soluble; Ox.-Oxidizing; Org.-Organic; B-p-Bleed-proof; Ket.-Ketones; Est.-Esters; Aro.-Aromatic; Hyd.-Hydrocarbons; Ali.-Aliphatic; Red.-reducing					P-Poor F-Fair G-Good Exc.-Excellent	T-Transparent TRL-Trans- lucent O-Opaque l.t.-Light transmission	
ery L	Sl. dark. of surface	N to Sl. (depending on acid)	Dec. by ox. acids; N to Sl. by red. and org. acids	N to Sl.	Dec.	None	F to G	T,TRL	1
ery L	General darkening			Slight to marked depending on alkalinity	At. unless special alkali-resistant resin is used	None on bleed-proof materials	F to G	O	2
N	General darkening						P	O	3
N	General darkening						P	O	4
N	General darkening						P	O	5
most N	General darkening						F to G	O	6
L to SE	General darkening						F to G	O	7
S	General darkening						G	O	8
ery S	General darkening						G	O	9
S	General darkening						G	O	10
ery S	Colors may fade				Dec.	At. by some	Exc.	T,TRL,O	11
most N	Darkens	N to Sl.	At. by ox. acids	None	Dec.	At. by some	G to F	O	12
most N	Sl. dark.	N to Sl.		None	Dec.	Generally R	F to G	O	13
ery L	Darkens	N to Sl.		Sl. to marked	Dec.	None	G	O	14
S	None	N to Sl.		None	N to Sl.	R	F to G	O	15
ery L	None	N to Sl.	Dec. or surface at.	Sl. to marked	Dec.	N to Sl.	F	TRL,O	16
SE	Colors may fade	None	—	None	—	None	—	Opalescent	17
N	Sl. color change	None	Dec.	None	At.	None	F	TRL	18
N	Sl. color change	N to Sl.	Dec.	None	Dec.	None	G	O	19
N	Sl. color change	N to Sl.	Dec.	None	Dec.	None on b-p colors	G	O	20
N	Sl. color change	N to Sl.	Dec.	At. very slightly	Slight At.	None	F	O	21
N	Sl. dis-coloration	None	Dec.	None	At.	None on bleed-proof colors	G	O	22
ery L	Color darkens	None	Dec.	None	At.		G	O	23
N	Slight	None	Dec.	None	N to Sl.	None	G	O	24
S	None	None	At. by some	None	Sl.	Generally R	G	TRL	25
S	None	None	At. by some	None	None	Generally R	G	T	26
to S	None to Sl.	N to Sl.	Slight	N to Sl.	None to marked	At. by some	F to G	O	27
to S	None to Sl.	N to Sl.	Slight	N to Sl.	None to marked	At. by some	F	O	28
to S	None to Sl.	N to Sl.	Slight	N to Sl.	Sl. to marked	At. by some	F	O	29
S	Sl. (when stabilized)	Slight	Dec.	None	Slight	Widely sol.	G	T,TRL,O	30
to SE	Slight	Slight	Dec.	Slight	Dec.	Sol. in ketones esters;	G	T,TRL,O	31
to SE	Slight	Slight	Dec.	Slight	Dec.		G	T,TRL,O	32
to SE	Slight	Slight	Dec.	Slight	Dec.		G	T,TRL,O	33

MANUFACTURERS (See list at right of chart for key to numbers)	TRADE DESIGNATIONS (Numbers in parentheses refer to list of manufacturers)
89, 115	Bakelite (19), Conolon (101), Durez (47), Durite (22), Fiberfil (53), Fiberite (54), GE (62), Heresite (75), Indur (110), Insurok (125), Kaston (115), Kys-ite (83), Lamophene (115), Loven (89), Mouldrite PF (78), Neillite (149), Plenco (113), Protectophene (115), Pyrotex (120), Resinox (97), Rockite (25), Rogers (127), Synvar PM (142), Valite (148)
19, 22, 25, 28, 47, 54, 62, 75, 78, 89, 97, 110, 113, 125, 127, 142, 148, 149	
19, 22, 47, 54, 62, 75, 89, 97, 113, 115, 120, 125, 127, 142, 149	
19, 22, 25, 47, 62, 97, 113, 142	
47, 53, 54, 62, 89, 97, 101, 125, 127	
22, 47, 54, 62, 89, 97, 113, 125, 127	
83, 125, 127	
47, 62, 97, 142	
62, 97, 127, 142	
62, 97, 127	
84, 89, 91, 115	Gemstone (84), Kaston (115), Loven (89), Marblette (91)
16, 22, 32, 34, 47, 62, 73, 88, 89, 91, 97, 115, 121, 142	Catalin (32), Durez (47), Durite (22), GE (62), Haveg (73), Kaston (115), Korez S (16), Lebec (88), Loven (89), Marblette (91), Nobelion (121), Plyophen (121), Resinox (97), Synvaren (142)
1, 47, 89, 115, 127, 142	
16, 34, 58, 73, 89, 147	Atlasware (16), Duralon (147), Haveg (73), Jet-Kote (58), Loven (89)
6, 20, 28, 78, 89, 141	Beetle (6), Loven (89), Mouldrite UF (78), Plaskon (20), Sylplast (141)
6	Cymel (6), Fiberite (54), Melantine (36), Permelite (93), Plaskon (20), Resimene (97)
6, 20, 36, 54, 93, 97	
54, 93	
16, 19, 21, 22, 25, 26, 34, 36, 39, 51, 52, 58, 76, 77, 81, 87, 89, 91, 106, 115, 121, 122, 133, 147	Alfane (16), Araldite (36), Bakelite (19), Cadco (26), Cardolite (81), Cellobond (25), Cordopreg (39), Ecco (51), Epiphen (22), Epocast (58), Epolac (87), Epon (133), Epoxylite (52), Helix (21), Hysol (77), Marblette (91), Nureco (106), Polykast (115), Polytool (121), Ren (122), Stycast (51), Tygofil (147), Tygoweld (147)
15, 16, 21, 30, 34, 37, 58, 77, 89, 91, 106, 119, 121, 124, 143, 147	Amphesive (16), Epocast (58), Helix (21), Hysol (77), Nureco (rubber-modified epoxy) (106), Polytool (121), Thiokol (143)
120	Pyrotex (120)
19, 62	Bakelite (19), GE (62)
19, 45, 62, 101	Bakelite (19), Dow Corning (45), GE (62), Narmcloth (101)
10, 27, 42, 44, 65, 74, 80, 105, 137	Ampacet (10), Campco (27), Ethocel (44), Gering EC (65), Hercocel E (74), Interplastics (80), Joda E/C (42), Nixon E/C (105), Soplasco (137)
26, 27, 33, 42, 46, 49, 65, 74, 89, 95, 97, 105, 112, 130, 137, 153	Ampacet (10), Cadco (26), Campco (27), Celanese (33), Cellomold (25), Fiberfil (53), Gering CA (65), Hercocel A, W (74), Interplastics (80), Joda C/A (42), Kodapak I and IV (49), Midwest-Midlon A (95), Nixon C/A (105), Plastacele (46), Sandee (130), Soplasco (137), Tenite Acetate (48), Vuepak (97), Wopalit (153), Wopalon (153)
10, 33, 42, 48, 53, 65, 74, 80, 89, 97, 153	
25, 42, 49, 65, 74, 137	
33	Forticel (33)
3, 18, 26, 27, 42, 49, 53, 63, 65, 95, 105, 112, 135, 137	Cadco (26), Campco (27), Fairylite (135), Fiberfil (53), Genco (63), Gering CAB (65), Joda C/AB (42), Kodapak II (49), Midwest-Midlon (95), Nixon CAB (105), Non-Flam (135), Soplasco (137)

MANUFACTURERS

1. Acme Resin Corp., 1401 Circle Ave., Forest Park, Ill.
2. Acryvin Corp. of America, 470 E. 99th St., Brooklyn 36, N. Y.
3. Allied Resinous Products, Inc., 525 W. Adams St., Conneaut, Ohio
4. American Agile Corp., Maple Hgts., Ohio
5. American Alkyd Industries, Broad and 14th Sts., Carlstadt, N. J.
6. American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.
7. American Hard Rubber Co., 93 Worth St., New York 13, N. Y.
8. American Insulator Corp., New Freedom, Pa.
9. American Lucoflex, Inc., 500 Fifth Ave., New York 36, N. Y.
10. American Molding Powder & Chemical Corp., 703 Bedford Ave., Brooklyn 6, N. Y.
11. American Plastics Corp., 342 Madison Ave., New York 17, N. Y.
12. American Reinforced Sales, 650 S. Spring St., Los Angeles 14, Calif.
13. Anchor Plastics Co., 36-36 36th St., Long Island City 6, N. Y.
14. Archer-Daniels-Midland Co., Chemical Products Div., 2191 W. 110th St., Cleveland 2, Ohio
15. Armstrong and Associates, C. W., Argonne Road, Warsaw, Ind.
16. Atlas Mineral Products Co., The, Mertztown, Pa.
17. Atlas Powder Co., Wilmington 99, Del.
18. Auburn Button Works, Inc., 48 Canoga St., Auburn, N. Y.
19. Bakelite Co., Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.
20. Barrett Div., Allied Chemicals & Dye Corp., 40 Rector St., New York 6, N. Y.
21. Biggs Co., Inc., Carl H., 2255 Barry Ave., Los Angeles 64, Calif.
22. Borden Co., The, Chemical Div., 350 Madison Ave., New York 17, N. Y.
23. Borden Co., The, Chemical Div., Resinite Dept., Santa Barbara, Calif.
24. British Geon Ltd., London S. W. 1, England
25. British Resin Products Ltd., London S. W. 1, England
26. Cadillac Plastic and Chemical Co., 15111 Second Ave., Detroit 3, Mich.
27. Campco Div., Chicago Molded Products Corp., 2717 N. Normandy Ave., Chicago 35, Ill.
28. Canadian Industries Ltd., P.O. Box 10, Montreal, P.Q., Canada
29. Capac Industries, Inc., Capac, Mich.
30. Carboline Co., 331 Thornton Ave., St. Louis 19, Mo.
31. Cast Optics Corp., 123 Newman St., Hackensack, N. J.
32. Catalin Corp. of America, 1 Park Ave., New York 16, N. Y.
33. Celanese Corp. of America, Marco Products Dept., 290 Ferry St., Newark 5, N. J.
34. Chemical Coatings and Engineering Co., Inc., 2633 Westchester Pike, Broomall, Pa.
35. Chemore Corp., 21 West St., New York 6, N. Y.
36. Ciba Co., Inc., Plastics Div., Kimberton, Pa.
37. Coast Pro-Seal Mfg. Div., 1507 Grand Vista Ave., Los Angeles 23, Calif.
38. Columbia-Southern Chemical Corp., 1 Gateway Center, Pittsburgh 22, Pa.
39. Cordo Molding Products, Inc., 230 Park Ave., New York 17, N. Y.
40. Crane Packing Co., Teflon Products Div., 6400 Oakton St., Morton Grove, Ill.
41. Cutler-Hammer, Inc., 492 N. 12th St., Milwaukee 1, Wis.
42. Davis Plastics Co., Joseph, Arlington, N. J.
43. Dewey & Almy Chemical Co., 62 Whittemore Ave., Cambridge 40, Mass.
44. Dow Chemical Co., The, Midland, Mich.
45. Dow Corning Corp., Midland, Mich.
46. Du Pont de Nemours & Co., E.I., Wilmington 98, Del.
47. Durez Plastics Div., Hooker Electrochemical Co., 888 Walck Road, North Tonawanda, N. Y.
48. Eastman Chemical Products, Inc., Kingsport, Tenn.
49. Eastman Kodak Co., Rochester 4, N. Y.
50. Electronic Mechanics, Inc., Clifton, N. J.
51. Emerson and Cuming, Inc., Canton, Mass.
52. Epoxylite Corp., 10829 E. Central Ave., El Monte, Calif.
53. Fiberfil Corp., Warsaw, Ind.
54. Fiberite Corp., 516 W. Fourth St., Winona, Minn.
55. Firestone Plastics Co., P.O. Box 690, Pottstown, Pa.
56. Flexfirm Products, 2300 N. Chico Ave., El Monte, Calif.
57. Foster Grant Co., Inc., Petrochemical Div., 289 Main, N., Leominster, Mass.
58. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.
59. Garfield Mfg. Co., 10 Midland Ave., Garfield, N. J.
60. Garlock Packing Co., The, Palmyra, N. Y.
61. General Aniline & Film Corp., Commercial Development Dept., 435 Hudson St., New York 14, N. Y.
62. General Electric Co., 1 Plastics Ave., Pittsfield, Mass.
63. General Plastics Corp., 1400 N. Washington, Marion, Ind.
64. General Tire and Rubber Co., Chemical Div., 1708 Englewood Ave., Akron 9, Ohio
65. Gering Products, Inc., Kenilworth, N. J.
66. Gilman Brothers Co., The, Gilman, Conn.
67. Glaskyd Inc., 125 W. 3rd St., Perrysburg, Ohio
68. Glastic Corp., The, 4321 Glenridge Road, Cleveland 21, Ohio
69. Glidden Co., 11001 Madison Ave., Cleveland 2, Ohio
70. Goodrich Chemical Co., B. F., Cleveland 15, Ohio
71. Goodyear Tire & Rubber Co., Inc., The, Chemical Div., 1144 E. Market St., Akron 16, Ohio

SILICONE MOLDING COMPOUND	Asbestos filler	27	G	300-350	1000-5000	–	–	6-8	
	Mineral filler	28	F	300-350	2000-6000	–	–	2.1-2.8	
	Glass fiber filler	29	F	300-350	1000-5000	–	5000-10000	6-9	
CELLULOSIC MOLDING COMPOUNDS AND SHEETS	Ethyl cellulose molding compounds and sheets	30	Exc.	250-390	500-5000	350-500	8000-32000	1.8-2.4	
	CELLULOSE ACETATE — Sheet	31	Exc.	210-320	500-5000	–	–	–	
	CELLULOSE ACETATE — Molding and extrusion	32	Exc.	260-420	500-5000	335-490	8000-32000	2-2.6	
	Cellulose acetate, high acetyl	33	Exc.	210-390	500-5000	355-480	8000-32000	2.0-2.6	
	Cellulose propionate molding compound	34	Exc.	360-450	1000-5000	335-515	8000-32000	2.0-2.4	
	CELLULOSE ACETATE BUTYRATE — Sheet	35	Exc.	210-320	500-5000	–	–	–	
	CELLULOSE ACETATE BUTYRATE — Molding	36	Exc.	265-390	500-5000	335-480	8000-32000	2.0-2.4	
	Cellulose nitrate (pyroxylin)	37	G	185-250	2000-5000	–	–	–	
NYLON MOLDING COMPOUNDS	Injection molding and extrusion	38	Exc.	–	–	470-720	10000-25000	2.1-2.2	
	30% glass fiber filled	39	Exc.	–	–	500-700	15000-20000	2.0	
	Type 6	40	Exc.	–	–	440-720	10000-25000	–	
RUBBER MOLDING COMPOUNDS	Chlorinated rubber	41	F	280-340	2000-6000	300-340	3000-10000	2.2-2.6	
	HARD RUBBER — No filler	42	G	285-350	1200-1800	200-350	2000-5000	1-1.2	
	HARD RUBBER — Mineral filler	43	G	285-350	1200-1800	230-350	2000-5000	1-6	
Acrylonitrile Resin-Rubber Molding Compound		44	G	325-375	1000-8000	375-600	6000-30000	2.0-2.3	
COLD MOLDED	Non-refractory (organic)	45	F to G	–	2000-4000	–	–	2.5	
	Refractory (inorganic)	46	F to G	–	1000-10000	–	–	2.0-3.0	
INORGANIC MOLDED PLASTICS GLASS-BONDED MICA	Compression	47	F to G	1250 ▶	2000-4000	–	–	3-4	
	Injection	48	G	–	–	1200 ▶	10000-20000	–	
Vinyl Acetate Molding Compound		49	P	–	–	–	–	–	
VINYL CHLORIDE AND VINYL CHLORIDE-ACETATE MOLDING COMPOUNDS AND SHEETS, RODS, & TUBES	Rigid	50	Exc.	285-400	1500-2000	300-400	15000-40000	2.0-2.4	
	Flexible unfilled	51	G	285-350	500-2000	320-385	8000-25000	2.0-2.6	
	Flexible filled	52	G	285-350	500-2000	320-385	8000-25000	2.0-2.6	
Vinylidene Chloride Molding Compounds		53	Exc.	220-350	250-5000	300-400	10000-30000	2	
Vinyl Formal Molding Compound		54	G	300-350	1000-10000	300-400	10000-30000	–	
VINYL BUTYRAL MOLDING COMPOUNDS	Rigid	55	G	280-320	1000-2000	–	–	–	
	Flexible unfilled	56	G	280-320	100-3000	250-340	15000-30000	–	
Vinyl Alcohol Molding Compound		57	G	250-300	500-1500	–	–	–	
Vinyl Carbazole Molding Compound		58	F	340-460	–	430-600	–	–	
Glyceryl Phthalate Cast Resin		59	–	–	–	–	–	–	
Allyl Cast Resins		60	–	–	–	–	–	–	
POLYESTER CAST RESINS	Rigid	61	–	–	–	–	–	–	
	Flexible	62	–	–	–	–	–	–	
Diallyl Phthalate Molding Compound (Unfilled)		63	G	280-320	500-2000	–	–	–	
POLYESTER — GLASS FIBER FILLED	Preform moldings	64	Exc.	170-320	50-2000	–	–	–	
	Cloth moldings	65	Hand lay-up	150-250	0-300	–	–	–	

6-8	–	1.6-1.9	17.3-14.4	–	28000-35000	–	25-30	–	30000-35000			
2.1-2.8	0.005-0.010	1.65-2.0	16.8-13.8	–	2500-4300	–	–	16000-24000	6800-7700	0.25-0.38	M89	
6-9	0-0.005	1.68-2.0	16.5-13.8	–	4000-5000	–	–	9000-15000	9000-14000	3-15	M45	
1.8-2.4	0.005-0.009	1.09-1.17	25.5-23.6	1.47	2000-8000	5-40	1.0-3.0	10000-35000	4000-12000	2.0-8.0 0.3-1.7 @ -40° F.	R50-R115	
–	See footnote[1]	1.28-1.32	21.6-20.9	1.49-1.50	4500-8000	20-50	2.5-4	18000-25000	6000-10000	1.0-3.0	R95-R120	
2-2.6	See footnote[1]	1.24-1.34	22.4-20.6	1.46-1.50	1900-8500	6-70	0.86-4.0	13000-36000	2000-16000	0.4-5.2	R35-R125	
2.0-2.6	See footnote[1]	1.26-1.34	22.0-20.6	1.46-1.50	3000-11000	4-55	1.0-4.5	14000-36000	3500-13000	0.4-5.2	R65-R125	
2.0-2.4	L=0.001-0.005; C=0.003-0.009	1.18-1.24	23.4-22.7	1.47-1.48	2000-7000	45-60	0.6-1.5	7000-22000	3000-11000	0.5-11	R20-R115	5.
–	–	1.15-1.22	24.0-22.7	1.46-1.49	2600-6900	40-80	0.7-2.5	–	4000-9000	0.8-6.3	R30-R115	
2.0-2.4	L=0.002-0.005; C=0.003-0.009	1.15-1.22	24.0-22.7	1.46-1.49	2600-6900	40-88	0.7-2.0	7500-22000	1800-9300	0.8-6.3	R30-R115	
–	–	1.35-1.40	20.5-19.8	1.49-1.51	7000-8000	40-45	1.9-2.2	22000-35000	9000-11000	5.0-7.0	R95-R115	
2.1-2.2	0.015	1.09-1.14	25.5-24.2	1.53	7000-10900	90	2.6-4.0	7200-13000	8000-13800	1.0	R111-R118	
2.0	0.003-0.005	1.33	22.2	–	18000-20000	6.5-8.5	–	–	–	Variable	–	
–	0.021-0.022	1.136-1.141	24.5-24.2	–	10200-12000	90-320	1.5-3.6	6700-9700	3500-4200	1.0-3.0	R103-R118	
2.2-2.6	–	1.64	16.9	1.56	2700-5000	0.5-2.2	1-6	–	9000-16000	0.14-2.8	M80-M110	
1-1.2	0.006-0.032	1.14	24.2	–	8000-10000	5-7.5	3.0	8000-12000	15000	0.5	L85-L100	
1-6	0.006-0.012	1.30-1.82	21.3-15.2	–	1000-4000	1-3	1.5	–	7500	0.2-0.4	L85-L100	
2.0-2.3	0.003-0.004	1.01-1.10	27.4-25.2	–	3000-6000	Up to 50	1.8-4.0	4000-9000	4000-11500	0.4-9.0	R60-R110	
2.5	0.010-0.017	1.87-2.15	14.8-12.9	–	1400-3000	–	–	6000-15000	3700-10000	0.4	•M80-M90	
2.0-3.0	0.000-0.010	1.60-2.2	17.3-12.7	–	2200	–	–	18000	2000-7500	0.4	M75-M95	
3-4	0.000	3.0	9.1	–	6000-9500	–	90-120	35000-42000	15000-19000	1.8	M110-M120	
–	0.000	2.6-3.8	10.5-7.4	–	6000	–	70-80	23000	13000	0.6-0.7	M115-M130	
–	–	1.18-1.20	23.4-23.0	1.45-1.47	Up to 5000	–	–	–	–	–	–	
2.0-2.4	0.001-0.004	1.35-1.45	20.5-19.1	1.52-1.55	5000-9000	2.0-40	3.5-6	8000-13000	10000-16000	0.4-20	70-90 (Shore)	
2.0-2.6	[2]0.010-0.050	1.16-1.35	23.8-20.5	–	1500-3500	200-450	–	900-1700	–	Varies depending on type and amount of plasticizer	–	
2.0-2.6	0.010-0.035	1.3-1.7	21.3-16.3	–	1000-3500	200-400	–	1000-1800	–		–	
2	0.005-0.025	1.65-1.72	16.8-16.1	1.60-1.63	3000-5000	Up to 250	0.5-0.8	2000-2700	4300-6100	0.3-1.0	M50-M65	
–	0.0015-0.003	1.2-1.4	23.0-19.8	1.50	10000-12000	5-20	3.5-6.0	–	17000-18000	0.8-1.4	M85	
–	–	1.07-1.20	25.8-23.0	1.48-1.49	4000-8500	5-60	3.5-4.0	–	10000	0.74-0.82	–	
–	–	1.05	26.2	1.47-1.49	500-3000	150-450	–	–	Varies depending on type and amount of plasticizer		10-100 (Shore)	
–	–	1.21-1.31	22.9-21.1	1.49-1.53	1000-5000	300-600	–	–	–	–	10-100 (Shore)	
–	–	1.20	23.0	–	–	–	–	–	1500-6000	–	–	
–	–	1.40-1.41	19.8-19.7	1.57	8500-10500	–	3.75-7	20000-30000	10000-15000	0.45-0.55	M115-M120	
–	–	1.30-1.40	20.9-19.8	1.50-1.575	5000-6000	–	3.0	21000-23000	6000-13000	0.2-0.4	M95-M120	
–	–	1.10-1.46	25.2-19.0	1.523-1.57	6000-10000	<5	3.0-6.4	13000-36500	8500-18300	0.2-0.4	M70-M115	
–	–	1.01-1.20	27.4-23.0	1.537-1.55	800-1800	40-310	–	–	–	>7.0	84-94 (Shore)	
–	–	1.27	21.8	1.571	3000-4000	–	–	22000-24000	10000-11000	0.2-0.3	M114-M116	
–	0-.002	1.35-2.0	20.5-13.9	–	7000-8000	.5-5.0	8.0-20.0	15000-30000	8000-10000	5-30	M70-M120	
–	0-.002	1.50-2.1	18.5-13.2	–	30000-50000	.5-2.0	15.0-45.0	25000-50000	40000-80000	5-30	M80-M120	

–	–	–	–	–	–	–	–	–	–	–
16000-24000	6800-7700	0.25-0.38	M89	3.7-4.0	1-3	5.0-5.8	>480	340->500	3×10^7-7×10^8	370-
9000-15000	9000-14000	3-15	M45	3.7-4.0	1-3	0.8	>480	>500->900	10^7-10^{13}	185-
10000-35000	4000-12000	2.0-8.0 0.3-1.7 @ -40° F.	R50-R115	3.8-7	0.3-0.75	10-20	115-185	115-190	10^{13}-10^{14}	350-
18000-25000	6000-10000	1.0-3.0	R95-R120	4-8	0.3-0.5	10-15	140-220	130-160	10^{11}-10^{13}	250-
13000-36000	2000-16000	0.4-5.2	R35-R125	4-8	0.3-0.42	8-16	140-220	110-205	10^{10}-10^{13}	250-
14000-36000	3500-13000	0.4-5.2	R65-R125	4-8	0.3-0.42	8-16	150-220	120-210	10^{10}-10^{13}	250-
7000-22000	3000-11000	0.5-11	R20-R115	5.28-5.36	0.38-0.40	11-17	155-220	110-180	10^{12}-10^{13}	300-
–	4000-9000	0.8-6.3	R30-R115	4-8	0.3-0.4	11-17	140-220	115-200	10^{10}-10^{12}	250-
7500-22000	1800-9300	0.8-6.3	R30-R115	4-8	0.3-0.4	11-17	140-220	115-200	10^{10}-10^{12}	250-
22000-35000	9000-11000	5.0-7.0	R95-R115	5.5	0.3-0.4	8-12	ca. 140	140-160	$(10\text{-}15) \times 10^{10}$	300-
7200-13000	8000-13800	1.0	R111-R118	5.2-5.8	0.4	10-15	270-300	300-360 (66 psi)	$(0.45\text{-}4) \times 10^{14}$	385-
–	–	Variable	–	–	–	Low	300-400	–	–	–
6700-9700	3500-4200	1.0-3.0	R103-R118	–	–	4.6-7.1	–	260-340 (66 psi)	10^9-10^{12}	210-
–	9000-16000	0.14-2.8	M80-M110	3.0	0.39-0.43	12-13	–	140	1.5×10^{13}	–
8000-12000	15000	0.5	L85-L100	2.9	0.40	7.7	–	140	2×10^{13}	47
–	7500	0.2-0.4	L85-L100	5.0	0.28	5.4	–	260	2×10^{13}	40
4000-9000	4000-11500	0.4-9.0	R60-R110	3.4	0.35	6-13	150-175	170-195	0.5×10^{13}->10^{14}	310-
6000-15000	3700-10000	0.4	M80-M90	–	–	–	500	>400	1.3×10^{13}	85-
18000	2000-7500	0.4	M75-M95	–	–	–	900-1300	>400	–	4
35000-42000	15000-19000	1.8	M110-M120	12	0.16	1	600-1000	850	10^{14}-10^{15}	–
23000	13000	0.6-0.7	M115-M130	9.5-13	0.13-0.24	1-1.1	500-900	700	10^{14}-10^{17}	–
–	–	–	–	–	0.39	23-30	–	100	–	–
8000-13000	10000-16000	0.4-20	70-90 (Shore)	3.0-7.0	0.2-0.28	5-18.5	120-160	130-170	$>10^{16}$	425-
900-1700	–	Varies depending on type and amount of plasticizer	–	3.0-4.0	0.3-0.5	7-25	150-175	–	10^{11}-10^{13}	300-
1000-1800	–		–	3.0-4.0	0.3-0.5	–	150-175	–	10^{11}-10^{14}	250-
2000-2700	4300-6100	0.3-1.0	M50-M65	3.0	0.32	19	160-200	130-150	10^{14}-10^{16}	350
–	17000-18000	0.8-1.4	M85	3.7	–	6.4	120-150	150-170	–	490
–	10000	0.74-0.82	–	–	–	8-22	115	115-140	$>10^{14}$	400
–	Varies depending on type and amount of plasticizer		10-100 (Shore)	–	–	–	–	–	5×10^{10}	350
–	–	–	10-100 (Shore)	–	–	7-12	–	–		U
–	1500-6000	–	–	–	0.3	5-8	–	210-300	10^{15}-10^{16}	750-1
20000-30000	10000-15000	0.45-0.55	M115-M120	–	–	5.5-6.0	250	175-195	$>10^{14}$	–
21000-23000	6000-13000	0.2-0.4	M95-M120	4.8-5	0.26-0.55	5-10	212	140-190	$>4 \times 10^{14}$	380
13000-36500	8500-18300	0.2-0.4	M70-M115	4	–	5.5-10	250	140-400	10^{14}	380-5
–	–	>7.0	84-94 (Shore)	–	–	–	250	–	–	250-4
22000-24000	10000-11000	0.2-0.3	M114-M116	–	–	–	–	310	10^{14}	–
15000-30000	8000-10000	5-20								

	–	–	–	–	–	–	–	–	–	–	N
10^8	370-400	320-400	4.0-5.0	3.7-5.0	3.7-5.0	0.003-0.013	0.002-0.011	0.003-0.006	250-420	0.2-0.5	N
	185-200	125-300	4.0-5.0	3.7-4.9	3.6-4.6	0.005-0.0065	0.005-0.0075	0.004-0.0065	220-350	0.1	N
	350-500	300-530	3.0-4.2	3.0-4.1	2.8-3.9	0.005-0.020	0.002-0.020	0.010-0.060	150-200	0.8-1.8	
	250-300	–	5.3-5.8	5.0-6.0	4.0-5.5	0.02-0.03	0.025-0.04	0.04-0.06	180-200	2.0-4.5	S to
	250-365	200-300	3.5-7.5	3.5-7.0	3.2-7.0	0.01-0.06	0.01-0.06	0.01-0.10	50-310	1.9-6.5	S to
	250-365	200-300	3.5-7.5	3.5-7.0	3.2-7.0	0.01-0.06	0.01-0.06	0.01-0.10	50-310	1.3-3.1	S to
	300-450	–	–	3.6-3.9	3.4-3.6	–	0.006-0.01	0.01-0.03	175-190	1.2-2.0	
	250-400	–	3.5-6.4	–	–	0.01-0.04	–	–	–	0.9-2.2	
	250-400	–	3.5-6.4	–	3.2-6.2	0.01-0.04	–	0.01-0.04	–	0.9-2.2	
10^{10}	300-600	250-550	7.0-7.5	7.0	6.4	0.09-0.12	0.03	0.06-0.09	–	1.0-2.0	Ver
10^{14}	385-470	340-410	4.1-4.6	4.0-4.5	3.4-3.5	0.014-0.04	0.02-0.04	0.03-0.04	130-140	0.4-1.5	Sl
	–	–	–	–	–	–	–	–	–	0.2-0.7	S to
	210-290	120-220	6.7-14.0	4.9-10.1	4.0-4.7	0.06-0.10	0.06-0.11	0.04-0.13	–	1.9-3.3	Sl
	–	–	3	3	–	0.003	–	0.006	–	0.1-0.3	N
	470	420	–	3.0	2.8	–	0.004	0.06	–	0.02	M
	400	350	–	5.8	–	–	0.006	–	–	0.02	M
10^{14}	310-350	310-350	3.4-4.75	3.5-4.5	3.2-4.0	0.009-0.02	0.02	0.017-0.026	–	0.2-0.3	S
	85-115	50-75	17-28	12-18	6.0	0.20	–	0.07	75-200	0.55-2.0	M
	45	50-80	–	–	–	–	–	–	100-500	0.5-15	M
	–	440-600	6.95-7.60	6.90-7.85	6.90-7.85	0.0035-0.007	0.0028-0.004	0.0015-0.002	300	Nil	N
	–	400-500	6.95-9.3	6.9-9.25	6.9-9.2	0.007-0.050	0.0038-0.020	0.0015-0.012	250	Nil	N
	–	–	2.7-6.1	–	–	0.025-0.070	–	–	–	3	S
	425-1300	375-750	3.2-3.6	3.0-3.3	2.8-3.1	0.007-0.02	0.009-0.017	0.006-0.019	60-80	0.07-0.4	SE
	300-1000	275-900	5.0-9.0	4.0-8.0	3.3-4.5	0.08-0.15	0.07-0.16	0.04-0.14	–	0.15-0.75	S to
	250-800	225-750	5.0-6.0	4.0-5.0	3.5-4.5	0.10-0.15	0.09-0.16	0.09-0.10	–	0.50-1.0	S to
	350	300	4.5-6.0	3.5-5.0	3.0-4.0	0.03-0.45	0.06-0.075	0.05-0.08	–	<0.1	SE
	490	455	3.7	3.6	3.0	0.013	0.019	0.023	–	0.5-3.0	S
	400	400	3.61	3.58	3.33	0.007	0.0075	0.0065	–	1.0-3.0	S
	350	325	5.60	5.10	3.92	0.115	0.057	0.061	–	1.0-2.0	S
	Under atmospheric conditions enough water will be absorbed to make these measurements useless								–	30 up	S
	750-1000	–	–	3.0	3.0	–	0.0004-0.001	0.0004-0.001	–	0.1	–
	–	300-350	4-4.5	4-4.5	3.7-4.0	0.003-0.004	0.006-0.008	0.025-0.035	250-270	–	S
	380	320	3.45-5.0	3.35-5.0	3.6-4.5	0.006-0.019	0.01	0.028-0.06	120-250	0.03-0.44	0.3 to
	380-500	280-420	3.0-4.36	2.8-5.2	2.8-4.1	0.003-0.028	0.005-0.025	0.006-0.026	125	0.15-0.60	1.1 to
	250-400	170	4.4-8.1	4.5-7.1	4.1-5.9	0.026-0.31	0.016-0.05	0.023-0.06	135	0.50-2.5	–
	–	450	3.7	3.7	3.5	0.010	0.010	0.013	118	0.0-0.2	0.5-0

–	–	–	–	N to S	None to Sl.	N to Sl.	Slight	N to Sl.	None to marked	At. by some	F to G	O
02-0.011	0.003-0.006	250-420	0.2-0.5	N to S	None to Sl.	N to Sl.	Slight	N to Sl.	None to marked	At. by some	F	O
05-0.0075	0.004-0.0065	220-350	0.1	N to S	None to Sl.	N to Sl.	Slight	N to Sl.	Sl. to marked	At. by some	F	O
02-0.020	0.010-0.060	150-200	0.8-1.8	S	Sl. (when stabilized)	Slight	Dec.	None	Slight	Widely sol.	G	T,TR
25-0.04	0.04-0.06	180-200	2.0-4.5	S to SE	Slight	Slight	Dec.	Slight	Dec.	Sol. in ketones esters; softened or slightly sol. in alcohol; little affected by hydrocarbons	G	T,TR
01-0.06	0.01-0.10	50-310	1.9-6.5	S to SE	Slight	Slight	Dec.	Slight	Dec.		G	T,TR
01-0.06	0.01-0.10	50-310	1.3-3.1	S to SE	Slight	Slight	Dec.	Slight	Dec.		G	T,TR
06-0.01	0.01-0.03	175-190	1.2-2.0	S	Slight	Slight	Dec.	Slight	Dec.		Exc.	T,TR
–	–	–	0.9-2.2	S	Slight	Slight	Dec.	Slight	Dec.		G	T,TR
–	0.01-0.04	–	0.9-2.2	S	Slight	Slight	Dec.	Slight	Dec.		G	T,TR
0.03	0.06-0.09	–	1.0-2.0	Very F	Dis., becomes brittle	Slight	Dec.	Slight	Dec.		Exc.	T,TR
02-0.04	0.03-0.04	130-140	0.4-1.5	SE	Sl. dis.	R	At.	None	None	R to common solv.	Exc.	TRL
–	–	–	0.2-0.7	S to SE	Very little dis.	R	At.	None	Surface only	R to most solvents	Exc.	TRL t
06-0.11	0.04-0.13	–	1.9-3.3	SE	–	R	At.	None	None	R to common solv.	Exc.	TRL t
–	0.006	–	0.1-0.3	N	Darkens	R	R	R	R	Sol. in aro. hyd.	–	TRL t
.004	0.06	–	0.02	M	Dis.[4]	R	At. by ox. acids	R	R	At. by some	G	O
.006	–	–	0.02	M	Dis.	R	At. by ox. acids	R	R	At. by some	F	O
0.02	0.017-0.026	–	0.2-0.3	S	None to mod.	None	At. by ox. acids	None	None	R, some[7] Sol. in some[7]	G	O
–	0.07	75-200	0.55-2.0	N	–	Slight	Dec.	None	Dec.	At. by some	P to F	O
–	–	100-500	0.5-15	N	None	Slight	Dec.	None	None	None	P	O
8-0.004	0.0015-0.002	300	Nil	N	None	Slight	Dec.	Slight	Dec.	None	G	O
8-0.020	0.0015-0.012	250	Nil	N	None	Slight	Dec.	Slight	Dec.	None	G	O
–	–	–	3	S	None	None	At.	None	At.	Sol. in many	–	T
9-0.017	0.006-0.019	60-80	0.07-0.4	SE	Dark. on prolonged intense exposure	None	None	None	None	R alcohols, ali. hyd., oils; Sol. in ket. and est.; Sw. in aro. hyd.	Exc.	T to
7-0.16	0.04-0.14	–	0.15-0.75	S to SE		None	N to Sl.	None	None		–	T to
9-0.16	0.09-0.10	–	0.50-1.0	S to SE		None	N to Sl.	None	None		–	TRL t
6-0.075	0.05-0.08	–	<0.1	SE	Slight	None	Highly R	R	R	R	G	TRL t
019	0.023	–	0.5-3.0	S	Slight	At.	At.	R	R	At. by some	G to P	T to
075	0.0065	–	1.0-3.0	S	Slight	Slight	Sl.	Slight	Slight	See footnote[9]	G	T to
057	0.061	–	1.0-2.0	S	Slight	Slight	Sl.	Slight	Slight		–	T to
		–	30 up	S	None	Softens or dis.	At.	Softens or dis.	Softens or dis.	Very R or not at.	P to G	T to
-0.001	0.0004-0.001	–	0.1	–	Slight	None	At. by ox. acids	None	–	Soluble	P to G	O
-0.008	0.025-0.035	250-270	–	S	Yel.	N to Sl.	At. by ox. acids	N to Sl.	Dec.	At. by some	Exc.	T to
.01	0.028-0.06	120-250	0.03-0.44	0.3 to SE	Very sl. yel.	None	At. only by ox. acids	None	N to Sl.	R	G	T (90-9 l.t.)
-0.025	0.006-0.026	125	0.15-0.60	1.1 to SE	Sl. yel.	None	N to considerable	N to Sl.	At.	At. by ket., chlorinated solvents	G	T to
-0.05	0.023-0.06	135	0.50-2.5	–	–	None	N to considerable	N to Sl.	At.		F	T to
010	0.013	118	0.0-0.2	0.5-0.6	Slight	None	None	None	–	R	G	T

	T	26	97, 105, 112, 130, 137, 153
	O	27	10, 33, 42, 48, 53, 65, 74, 80, 89, 97, 153
	O	28	
	O	29	25, 42, 49, 65, 74, 137
	T, TRL, O	30	33
	T, TRL, O	31	3, 18, 26, 27, 42, 49, 53, 63, 65, 95, 105, 112, 135, 137
	T, TRL, O	32	
	T, TRL, O	33	
	T, TRL, O	34	48
	T, TRL, O	35	42, 46, 97, 105, 153
	T, TRL, O	36	20, 26, 28, 32, 46, 53, 57, 65, 72, 78, 80, 89, 90, 102, 117
	T, TRL, O	37	
	TRL, O	38	53
	TRL to O	39	138
	TRL to O	40	7, 28, 74, 78
	TRL to O	41	7, 90, 125, 139
	O	42	104
	O	43	7, 8, 41, 59, 129
	O	44	
	O	45	8, 41, 59, 129
	O	46	50, 62, 100
	O	47	
	O	48	22, 132
	T	49	4, 7, 9, 10, 18, 19, 22, 23, 24, 26, 28, 35, 42, 53, 55, 64, 65, 70, 71, 78, 80, 90, 97, 103, 104, 105, 118, 131, 137, 139, 147, 153
	T to O	50	
	T to O	51	
	TRL to O	52	
	TRL to O	53	
	T to O	54	18, 44, 65, 70, 118
	T to O	55	132
	T to O	56	19, 46, 97, 132
	T to O	57	23, 46, 123, 132
	O	58	61
	T to O	59	32
	T (90-92% Lt.)	60	6, 31, 38, 76, 107, 109
	T to O	61	2, 5, 6, 17, 19, 20, 21, 25, 26, 33, 47, 51, 62, 64, 69, 76, 79, 89, 96, 104, 111, 121, 126
	T to O	62	
	T		

97, 105, 112, 130, 137, 153	CA (65), Hercocel A, W (74), Interplastics (80), Joda C/A (42), Kodapak I and IV (49), Midwest-Midlon A (95), Nixon C/A (105), Plastacele (46), Sandee (130), Soplasco (137), Tenite Acetate (48), Vuepak (97), Wopalit (153), Wopalon (153)
10, 33, 42, 48, 53, 65, 74, 80, 89, 97, 153	
25, 42, 49, 65, 74, 137	
33	Forticel (33)
3, 18, 26, 27, 42, 49, 53, 63, 65, 95, 105, 112, 135, 137	Cadco (26), Campco (27), Fairylite (135), Fiberfil (53), Genco (63), Gering CAB (65), Joda C/AB (42), Kodapak II (49), Midwest-Midlon (95), Nixon CAB (105), Non-Flam (135), Soplasco (137)
48	Tenite Butyrate (48)
42, 46, 97, 105, 153	Joda C/N (42), Nitron (97), Nixon C/N (105), Pyralin (46), Wopaloid (153)
20, 26, 28, 32, 46, 53, 57, 65, 72, 78, 80, 89, 90, 102, 117	Cadco (26), Catalin (32), Fiberfil (53), Gering NRW (65), Interplastics (80), Loven (89), Marsanyl (78), Nylasint (102), Nylatron (102), Plaskon (20), Polypenco-N (117), Zytel (46)
53	Fiberfil (53)
138	Spencer nylon (138)
7, 28, 74, 78	Ace (7), Alloprene (78), Parlon (74)
7, 90, 125, 139	Ace (7), Luzerne (90), Rub-Erok (125), Stokohard (139), Stoko-Therm (139)
104	Kralastic (104)
7, 8, 41, 59, 129	Ace Tex (7), Aico (8), Amerine (8), Garit (59), Gummon (59), Rosite (129), Tegit (59), Thermoplax (41)
8, 41, 59, 129	Aico (8), Hemit (59), Rosite (129), Thermoplax (41)
50, 62, 100	GE Mycalex (62), Mycalex (100), Mykroy (50), Supramica (100)
22, 132	Gelva (132), Lemac (22)
4, 7, 9, 10, 18, 19, 22, 23, 24, 26, 28, 35, 42, 53, 55, 64, 65, 70, 71, 78, 80, 90, 97, 103, 104, 105, 118, 131, 137, 139, 147, 153	Ace-Flex (7), Ace Rivicior (7), Agilide (4), Agilux (4), Ampacet (10), Bakelite (19), Borden PVC (22), Breon (24), Cadco (26), Corvic (78), Darvic (78), Exon (55), Fiberfil (53), Geon (70), Gering (65), Interplastics (80), Joda (42), Marvinol (104), Natvar (103), Nixon Vine-L (105), Opalon (97), Pliovic (71), Resinite (23), Seilon (131), Soplasco (137), Stokes (139), Tygon (147), Velon (55), Vipla (35), Vygen (64), Welvic (78), Woparin (153)
18, 44, 65, 70, 118	Geon (70), Gering SRW (65), Saran (generic) (44)
132	Formvar (132)
19, 46, 97, 132	Bakelite (19), Butacite (46), Butvar (132), Saflex (97)
23, 46, 123, 132	Elvanol (powder) (46), Gelvatol (132), Lemol (23), Resistoflex (123)
61	Polectron (61)
32	Catalin (32)
6, 31, 38, 76, 107, 109	Cocor (31), CR (38), Dapon (107), Enduron (109), Laminac (6)
2, 5, 6, 17, 19, 20, 21, 25, 26, 33, 47, 51, 62, 64, 69, 76, 79, 89, 96, 104, 111, 121, 126	Amester (5), Atlac (17), Bakelite (19), Cadco (26), Cellobond (25), Fostercast (150), GE (62), Glidpol (69), Glykon (64), Helix (21), Hetron (47), IC (79), Laminac (6), Loven (89), Marco (33), Paraplex (149), Plastran (20), Plaskon

58 Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.
59 Garfield Mfg. Co., 10 Midland Ave., Garfield, N. J.
60 Garlock Packing Co., The, Palmyra, N. Y.
61 General Aniline & Film Corp., Commercial Development Dept., 435 Hudson St., New York 14, N. Y.
62 General Electric Co., 1 Plastics Ave., Pittsfield, Mass.
63 General Plastics Corp., 1400 N. Washington, Marion, Ind.
64 General Tire and Rubber Co., Chemical Div., 1708 Englewood Ave., Akron 9, Ohio
65 Gering Products, Inc., Kenilworth, N. J.
66 Gilman Brothers Co., The, Gilman, Conn.
67 Glaskyd Inc., 125 W. 3rd St., Perrysburg, Ohio
68 Glastic Corp., The, 4321 Glenridge Road, Cleveland 21, Ohio
69 Glidden Co., 11001 Madison Ave., Cleveland 2, Ohio
70 Goodrich Chemical Co., B. F., Cleveland 15, Ohio
71 Goodyear Tire & Rubber Co., Inc., The, Chemical Div., 1144 E. Market St., Akron 16, Ohio
72 H & R Industries, Nazareth, Pa.
73 Haveg Corp., Newark, Del.
74 Hercules Powder Co., Inc., Wilmington 99, Del.
75 Heresite & Chemical Co., Manitowoc, Wis.
76 Homalite Corp., The, Wilmington 4, Del.
77 Houghton Laboratories, Inc., 322 Bush St., Olean, N. Y.
78 Imperial Chemical Industries Ltd., London S.W. 1, England
79 Interchemical Corp., 67 W. 44th St., New York 36, N. Y.
80 Interplastics Corp., 120 E. 56th St., New York 22, N. Y.
81 Irvington Chemical Div., Minn. Mining & Mfg. Co., 500 Doremus Ave., Newark 5, N. J.
82 Kellogg Co., M.W., P.O. Box 469, Jersey City 3, N. J.
83 Keyes Fibre Co., Upper College Ave., Waterville, Me.
84 Knoedler Chemical Co., Lancaster, Pa.
85 Koppers Co., Inc., Koppers Bldg., Pittsburgh 19, Pa.
86 Lamex Chemical Corp., Sundial Ave., Manchester, N. H.
87 Lawrence Adhesive and Chemical Co., Inc., Lawrence, Mass.
88 Lebec Chemical Corp., Paramount, Calif.
89 Loven Chemical of Calif., 244 Pine St., Newhall, Calif.
90 Luzerne Rubber Co., Trenton, N. J.
91 Marblette Corp., 37-21 30th St., Long Island City 1, N. Y.
92 Marbon Chemical, Div. of Borg-Warner Corp., 7165 Chicago Ave., Gary, Ind.
93 Melamine Plastics, Inc., Winona, Minn.
94 Mesa Plastics Co., 11751 Mississippi Ave., Los Angeles 25, Calif.
95 Midwest Plastic Products Co., 1801 Chicago Rd., Chicago Heights, Ill.
96 Mol-Rez Div., American Petrochemical Corp., 3134 California St., Minneapolis 18, Minn.
97 Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.
98 Morrell Corp., George, Muskegon Heights, Mich.
99 Muehlstein, H. & Co., 60 E. 42nd St., New York 17, N. Y.
100 Mycalex Corp. of America, 125 Clifton Blvd., Clifton, N. J.
101 Narmco Resins and Coatings Co., 600 Victoria St., Costa Mesa, Calif.
102 National Polymer Products, Inc., 125 N. Fourth St., Reading, Pa.
103 Natvar Corp., P.O. Box 67, Rahway, N. J.
104 Naugatuck Chemical, Div. United States Rubber Co., 203 Elm St., Naugatuck, Conn.
105 Nixon Nitration Works, Nixon, N. J.
106 Nureco Inc., 1100 Pontiac Ave., Cranston 10, R. I.
107 Ohio-Apex Div., Food Machinery and Chemical Corp., Nitro, W. Va.
108 Phillips Petroleum Co., Bartlesville, Okla.
109 Pioneer Scientific Corp., Great Neck, N. Y.
110 Pitt-Consol Chemical Co., 191 Doremus Ave., Newark 5, N. J.
111 Pittsburgh Plate Glass Co., Paint Div., 1 Gateway Center, Pittsburgh 22, Pa.
112 Plastic Horizons, Inc., 2 E. 5th St., Paterson 1, N. J.
113 Plastics Engineering Co., Sheboygan, Wis.
114 Plicose Manufacturing Corp., 71 Box St., Brooklyn 22, N. Y.
115 Poly Resins, Sun Valley, Calif.
116 Polymer Corp. of Pa., 2150 Fairmont Ave., Reading, Pa.
117 Polypenco, Inc., 2150 Fairmont Ave., Reading, Pa.
118 Premier Thermo-Plastic Co., Middletown Road, Jeffersontown, Ky.
119 Products Research, 3126 Los Feliz Blvd., Los Angeles, Calif.
120 Raybestos-Manhattan, Inc., Manheim, Pa.
121 Reichhold Chemicals, Inc., 525 North Broadway, White Plains, N. Y.
122 Ren Plastics, Inc., 3179 S. Cedar Rd., Lansing 4, Mich.
123 Resistoflex Corp., Belleville 9, N. J.
124 Rezolin, Inc., 1651 18th St., Santa Monica, Calif.
125 Richardson Co., The, 2747 Lake St., Melrose Park, Ill.
126 Robertson Co., H.H., 2407 Farmers Bank Bldg., Pittsburgh 22, Pa.

Glyceryl Phthalate Cast Resin			59	–	–	–	–	–	–	
Allyl Cast Resins			60	–	–	–	–	–	–	
POLYESTER CAST RESINS	Rigid		61	–	–	–	–	–	–	
	Flexible		62	–	–	–	–	–	–	
Diallyl Phthalate Molding Compound (Unfilled)			63	G	280-320	500-2000	–	–	–	
POLYESTER AND DIALLYL PHTHALATE MOLDING COMPOUNDS	GLASS FIBER FILLED	Preform moldings	64	Exc.	170-320	50-2000	–	–	–	0
		Cloth moldings	65	Hand lay-up	150-250	0-300	–	–	–	0
	Granular and putty types, mineral filled		66	Exc.	280-330	100-1500	–	–	2.05-2.10	0.004
	Asbestos filled		67	Exc.	280-320	500-2000	–	–	2.0-2.5	.004
	Synthetic fiber filled		68	Exc.	280-320	500-3000	–	–	5	.005
Polyacrylic Ester (Filled and vulcanized)			69	G	300-325	500-1500	–	–	–	
METHYL METHACRYLATE RESIN	Cast		70	G	–	–	–	–	–	
	Molding		71	Exc.	300-375	2000-5000	380-490	10000-20000	1.6-2.0	C.=0.00 L.=0.002
Polymethyl Alpha-Chloroacrylate (Cast)			72	G	–	–	–	–	–	
Polymethyl-Styrene Molding Compounds			73	G	300-375	1000-8000	375-600	10000-30000	–	0.0035
POLYSTYRENE MOLDING COMPOUNDS AND SHEETS	Unfilled		74	Exc.	265-400	1000-10000	325-600	10000-30000	1.6-2.3	C.=0.00 L.=0.002
	30/35% glass fiber filled, general-purpose type		75	G	275-350	2000-5000	575	15000-20000	–	0.001
MODIFIED STYRENE MOLDING COMPOUNDS AND SHEETS	Heat and chemical resistant type		76	G	300-400	1000-5000	350-700	10000-33000	1.6-2.4	0.001
	Shock resistant type		77	Exc.	250-325	1000-8000	375-600	5000-30000	1.6-2.4	0.002
Acrylonitrile-Styrene Copolymer			78	G	300-400	1000-8000	350-600	10000-33000	1.6-2.4	0.002
Acrylonitrile-Butadiene-Styrene Copolymer			79	Exc.	300-350	1000-5000	350-475	20000	1.3	0.0
POLYETHYLENE MOLDING COMPOUNDS AND SHEETS	High modulus and density		80	Exc.	300-450	500-1000	330-600	10000-20000	2.0	0.02-
	Medium modulus and density		81	Exc.	300-350	500-3500	300-600	8000-20000	2.0	0.02-
	Lower modulus and density		82	Exc.	275-300	200	300-500	8000-15000	2.1-3.6	0.02-
Polychlorotrifluoroethylene			83	Exc.	445-500	500-15000	440-550	20000-40000	2.0	0.005-
Polytetrafluoroethylene Molding Compound			84	–	–	–	–	–	3.5-4.0	–
Casein Plastic			85	P	200-225	2000-2500	–	–	–	–

[1]Positive and injecti
positive 0.003-0.007; fl
[2]Varies with plasticiz

HOW TO USE MODERN PLASTICS ENCYCLOPEDIA'S NEW PLASTICS PROPERTIES CHART

This revised Plastics Properties Chart is designed to make it easier for the user to find specific information.

Vertical columns represent properties; horizontal columns represent plastics materials. To facilitate the selection of materials having desired properties, bars have been drawn in to supplement numerical values. Each bar (which appears below the numerical value) relates to the scale appearing at the top of each vertical column. Thus, for example, the user who is seeking a material with a high tensile strength can simply scan the vertical columns representing Tensile Strength and visually determine by means of the bars which plastics material fall into the higher strength range.

Circles (as opposed to bars) indicate single values (as opposed to a range of values). Arrows indicate ranges in which the upper limit exceeds the scale range. Arrow heads indicate numerical values which also exceed the scale range, but in such instances even the lower limits do not fall within the scale range. Open-ended bars indicate values which are "more than" or "less than" a given range; the side on which the bars are open distinguishes between "more than" and "less than" (e.g. bars open to the right indicate "more than"; bars open to the left indicate "less than").

For users seeking complete property information on a specific material, the chart can easily be read horizontally. The last two columns of the chart give the manufacturers and trade designations of each plastic material.

–	1.40-1.41	19.8-19.7	1.57	8500-10500	–	3.75-7	20000-30000	10000-15000	0.45-0.55	M115-M120	
–	1.30-1.40	20.9-19.8	1.50-1.575	5000-6000	–	3.0	21000-23000	6000-13000	0.2-0.4	M95-M120	
–	1.10-1.46	25.2-19.0	1.523-1.57	6000-10000	<5	3.0-6.4	13000-36500	8500-18300	0.2-0.4	M70-M115	
–	1.01-1.20	27.4-23.0	1.537-1.55	800-1800	40-310	–	–	–	>7.0	84-94 (Shore)	
–	1.27	21.8	1.571	3000-4000	–	–	22000-24000	10000-11000	0.2-0.3	M114-M116	
0-.002	1.35-2.0	20.5-13.9	–	7000-8000	.5-5.0	8.0-20.0	15000-30000	8000-10000	5-30	M70-M120	
0-.002	1.50-2.1	18.5-13.2	–	30000-50000	.5-2.0	15.0-45.0	25000-50000	40000-80000	5-30	M80-M120	
0.004-0.010	1.80-2.25	12.3-5.4	–	3000-4000	–	5-25	18000-25000	7500-10000	0.30-0.35	–	
.004-.007	1.65	16.8	–	4500-7000	–	–	22500	8000-10000	0.45-0.50	M99	
.005-.009	1.24-1.40	22.3	–	4500-6000	–	–	20000-30000	10000-12000	0.55-4.5	–	
–	1.3-1.5	21.3-18.5	–	1200-2000	300-600	0.002-0.004	–	–	–	40-90 (Shore)	
–	1.17-1.20	23.7-23.1	1.48-1.50	8000-11000	2-7	3.5-5.0	11000-19000	12000-17000	0.4-0.5	M80-M100	
C.=0.002-0.008; L.=0.002-0.008	1.17-1.20	23.7-23.1	1.49	7000-9000	3-10	4.5	12000-18000	13000-17000	0.4-0.5	M85-M105	
–	1.47-1.49	18.5	1.52	13500-16000	1.9-3.8	7.8	27000-34000	22000-24500	0.3-0.5	M115-M118	
0.0035-0.0046	1.03-1.06	26.9-26.1	1.559-1.581	6600-9000	2.2-2.5	4.0-4.6	–	12900-16000	0.33-0.40	–	
C.=0.001-0.006, L.=0.002-0.006	1.04-1.065	26.4-26.0	1.59-1.60	5000-9000	1.0-3.6	4-6	11500-16000	8000-16000	0.25-0.50	M65-M90	
0.001-0.005	1.33	–	–	10000-15000	75-1.02	12.0	–	16000-20000	1.5-2.5	M80-M90	
0.001-0.008	1.05-1.11	26.2-24.8	1.57-1.60	7000-12000	1.5-2.5	4-6	11500-16000	10000-17000	0.25-0.50	M65-M90	
0.002-0.01	0.98-1.10	28.1-25.2	–	3500-6500	10-90	1.8-4.5	4800-9000	5000-7000	0.5-11.0	M65-70; R50-100	
0.002-0.006	1.075-1.10	25.8-25.2	1.57	9500-12000	1.5-2.5	4-5	14000-16000	13000-17000	0.35-0.50	M80-M83	
0.006	1.01-1.05	27.4-26.2	–	4500	100	2	5100	6800	5	R90	
0.02-0.05	0.941-0.965	–	1.54	4000-5500	15-1000	1.5	2450	1400	3.0-4.5	D68 (Shore)	
0.02-0.05	0.926-0.940	–	–	2300-5500	50-500	0.25-0.55	–	4800-7000	0.5-5.5	D63-70 (Shore)	
0.02-0.05	0.910-0.925	–	1.51	1500-1850	200-675	0.19-0.35	–	–	>16	D44	
0.005-0.010	2.1	13.2	1.43	5700	100-200	2-3	32000-80000	8250	3.6	R110-R115	
–	2.1-2.2	13.2-12.6	1.35	1500-3000	100-200	0.58	1700	–	3.0	D50-D65 (Shore)	
–	1.35	20.5	–	10000	2.5	5.1-5.7	27000-53000	10000-18000	1.0	M70-M100	

e and injection 0.003-0.007; semi-
003-0.007; flash 0.008-0.010.
with plasticizer.

This chart covers molding and extrusion compounds, cast resins, and sheet, rod, and tube stock. The values for the properties in the chart are based upon maximum and minimum figures submitted by a number of manufacturers of each type of plastic material. Differences in these procedures and sizes of test specimens may lead to erroneous conclusions in some cases if direct comparisons are attempted.

20000-30000	10000-15000	0.45-0.55	M115-M120	–	–	5.5-6.0	250	175-195	$>10^{14}$	–	300-350	4-
21000-23000	6000-13000	0.2-0.4	M95-M120	4.8-5	0.26-0.55	5-10	212	140-190	$>4 \times 10^{14}$	380	320	3.45-
13000-36500	8500-18300	0.2-0.4	M70-M115	4	–	5.5-10	250	140-400	10^{14}	380-500	280-420	3.0-
–	–	>7.0	84-94 (Shore)	–	–	–	250	–	–	250-400	170	4.4-
22000-24000	10000-11000	0.2-0.3	M114-M116	–	–	–	–	310	10^{16}	–	450	3.
15000-30000	8000-10000	5-30	M70-M120	–	–	2-5	300-350	–	10^{14}	350-500	–	3.8-
25000-50000	40000-80000	5-30	M80-M120	–	–	1.5-3	300-350	–	10^{14}	350-500	–	4.1-
18000-25000	7500-10000	0.30-0.35	–	–	0.25	3.5	300-350	350-425	10^{14}	350-450	300-350	6.0-
22500	8000-10000	0.45-0.50	M99	–	–	–	450	315	6.6×10^{8}	380	290	–
20000-30000	10000-12000	0.55-4.5	–	–	–	–	430	240-290	10^{8}-10^{16}	365-400	330-350	3.
–	–	–	40-90 (Shore)	–	–	–	250-350	–	2×10^{11} at 70°C	400-700 at 70°C	–	4 at 7
11000-19000	12000-17000	0.4-0.5	M80-M100	4-6	0.35	5-9	140-200	150-210	$>10^{15}$	450-550	350-400	3.5-
12000-18000	13000-17000	0.4-0.5	M85-M105	4-6	0.35	5-9	140-190	160-195	$>10^{14}$	450-550	350-400	3.5-
27000-34000	22000-24500	0.3-0.5	M115-M118	5	0.31	6.2	240-250	275-284	–	–	–	–
–	12900-16000	0.33-0.40	–	–	–	–	210-212	213-215	2.65×10^{14}	610-890 (1/16")	–	–
11500-16000	8000-16000	0.25-0.50	M65-M90	2.4-3.3	0.32	6-8	150-205	160-210	10^{17}-10^{19}	500-700	400-600	2.45-
–	16000-20000	1.5-2.5	M80-M90	–	–	Low	–	218-236	–	–	–	–
11500-16000	10000-17000	0.25-0.50	M65-M90	1.9-3.0	0.32-0.35	6-8	170-200	180-235	10^{15}-10^{17}	400-600	300-500	2.45-
4800-9000	5000-7000	0.5-11.0	M65-70; R50-100	1.0-3.0	0.32-0.35	3.4-21	140-175	148-200	10^{12}-10^{17}	300-600	300-600	2.45-
14000-16000	13000-17000	0.35-0.50	M80-M83	2.9	0.32-0.34	6-8	190-195	195-200	10^{15}	400-425	300-400	2.5-
5100	6800	5	R90	4.5	0.38	10	200	200	8×10^{13}	410	410	2.
2450	1400	3.0-4.5	D68 (Shore)	–	–	13	250	165-175	6×10^{15}	500	–	2.3
–	4800-7000	0.5-5.5	D63-70 (Shore)	–	–	–	220-250	185 (66 p.s.i.)	–	500-700	500-700	2.2-
–	–	>16	D44	8.0	0.55	16-18	212	105-121	1.6×10^{13}	460	420	2.
32000-80000	8250	3.6	R110-R115	3.16	0.22	4.5-7.0	390	–	1.2×10^{15}	530	390	2.3
1700	–	3.0	D50-D65 (Shore)	6	0.25	10	500	250 (66 p.s.i.)	$>10^{15}$	480	430	2.0
27000-53000	10000-18000	1.0	M70-M100	–	–	4.1-6.8	275	300	–	400-700	–	–

[b]The values reported for this property depend on the size and shape of the test piece and the molding conditions. The maximum permissible service temperature will vary with the formulation of the material, design of the part, and service conditions such as amount of stressing, humidity, etc. Requirements for resistance to heat should be considered a special problem.

ast resins, and sheet, rod, and tube stock. The imum and minimum figures submitted by a number ces in these procedures and sizes of test speci- irect comparisons are attempted.

Special gra should always the producers of plastics are with materials

											ox. acids	
4-4.5	4-4.5	3.7-4.0	0.003-0.004	0.006-0.008	0.025-0.035	250-270	–	S	Yel.	N to Sl.	At. by ox. acids	N t
3.45-5.0	3.35-5.0	3.6-4.5	0.006-0.019	0.01	0.028-0.06	120-250	0.03-0.44	0.3 to SE	Very sl. yel.	None	At. only by ox. acids	N
3.0-4.36	2.8-5.2	2.8-4.1	0.003-0.028	0.005-0.025	0.006-0.026	125	0.15-0.60	1.1 to SE	Sl. yel.	None	N to considerable	N t
4.4-8.1	4.5-7.1	4.1-5.9	0.026-0.31	0.016-0.05	0.023-0.06	135	0.50-2.5	–	–	None	N to considerable	N t
3.7	3.7	3.5	0.010	0.010	0.013	118	0.0-0.2	0.5-0.6	Slight	None	None	N
3.8-6.0	4.0-6.0	3.5-5.5	.01-.04	.01-.05	.01-.03	60-120	.01-1.0	S to SE	Slight	Slight	At.	At
4.1-5.5	4.2-6.0	4.0-5.5	.01-.04	.01-.06	.01-.03	60-120	.05-.5	S to SE	Slight	Slight	At.	At
6.0-7.5	5.1-6.2	4.6-5.5	0.02-0.06	0.02-0.03	0.015-0.04	75-190	0.15-0.8	S to SE	None	None	None	At
–	5.2	4.5	–	0.11	0.04-0.06	138	0.14	SE	None	None	Slight	No
3.8	3.7	3.6	0.026	0.020-0.03	0.01-0.016	85-115	0.08-0.2	SE	None	None	Slight	No
4 at 70°C.	–	–	2 at 70°C.	–	–	–	–	F	None	Swells	Swells	Swe
3.5-4.5	3.0-3.5	2.2-3.2	0.05-0.06	0.04-0.06	0.02-0.03	No track	0.3-0.5	S	Very Sl.	Almost N	At. only by ox. acids	Almo
3.5-4.5	3.0-3.5	2.2-3.2	0.04-0.06	0.03-0.05	0.02-0.03	No track	0.3-0.4	S	Very Sl.	Almost N	At. only by ox. acids	Almo
–	–	2.8	–	–	0.012	–	0.1-0.2	SE	Very Sl.	Almost N	Almost N	Almo
–	2.52-2.92	2.48-2.81	–	0.0002-0.0057	0.0005-0.0078	–	0.05-0.31	S	Sl. yel.	None	At. by ox. acids	No
2.45-2.65	2.4-2.65	2.4-2.65	0.0001-0.0003	0.0001-0.0003	0.0001-0.0004	60-135	0.03-0.05	S	Sl. yel.	None	At. by ox. acids	No
–	–	–	–	–	–	–	0.05-0.10	S	Sl. yel.	None	At. by ox. acids	R
2.45-3.4	2.4-3.2	2.4-3.1	0.0005-0.003	0.0005-0.003	0.0005-0.005	60-135	0.05-0.40	S	Sl. yel.	None	At. by ox. acids	No
2.45-4.75	2.4-4.5	2.4-3.8	0.0003-0.02	0.0004-0.02	0.0004-0.02	20-100	0.1-0.55	S	Some strength loss	None	At. by ox. acids	No
2.5-3.4	2.5-3.2	2.5-3.1	0.006-0.010	0.006-0.010	0.006-0.010	100-150	0.20-0.50	S	Sl. yel.	None	At. by ox. acids	No
2.7	2.7	2.9	.008	.009	.009	80	0.3	S	Sl. yel.[3]	None	At. by ox. acids[4]	No
2.35	2.35	2.35	0.0005	0.0005	0.0005	–	0.01	S	Requires black	Very R	At. slowly by ox. acids	Very
2.2-2.4	2.2-2.4	2.2-2.4	<0.0005	<0.0005	<0.0005	200-235	<0.01	S	Surface crazing (except black and brown)	Very R		Very
2.3	2.3	2.3	<0.0005	<0.0005	<0.0005	135-160	<0.015	S		R	At. by ox. acids	R
2.3	2.8	2.5	0.015	0.024	0.010	>360	0.00	N	None	None	None	None
2.0	2.0	2.0	<0.003	<0.003	<0.003	>200	0.005	N	None	None	None	None
–	–	6.1-6.8	–	–	0.052	–	7-14	Very L	Colors may fade	R	Dec.	Dec.

[4]Surface resistivity decreases.
[5]Loss in surface ductility.
[6]In high concentration.
[7]Resists aliphatics; soluble in ketones, aromatic
[8]Resists aliphatic hydrocarbons and most oils; and aromatic hydrocarbons; dissolves in alcohols.
[9]Slightly soluble in ethylene dichloride and some solvents.
[10]Soluble in ketones, esters, and some chlorinated
[11]Variable. Attacked by ketones, esters, some ha
[12]Halogenated compounds cause slight swelling.

Special grades of materials are often available that excel in one particular property. The manufacturers should always be consulted before making a choice of material. In order to facilitate communications with the producers of these materials, the names and addresses of manufacturers of each of these chemical types of plastics are listed in the chart. Complete street addresses will be found in the Directory Section. Check with materials suppliers for type of filler desired.

-0.001	0.0004-0.001	–	0.1	–	Slight	None	At. by ox. acids	None	–	Soluble	P to G	O
-0.008	0.025-0.035	250-270	–	S	Yel.	N to Sl.	At. by ox. acids	N to Sl.	Dec.	At. by some	Exc.	T to O
.01	0.028-0.06	120-250	0.03-0.44	0.3 to SE	Very sl. yel.	None	At. only by ox. acids	None	N to Sl.	R	G	T (90-92% l.t.)
-0.025	0.006-0.026	125	0.15-0.60	1.1 to SE	Sl. yel.	None	N to considerable	N to Sl.	At.	At. by ket., chlorinated solvents	G	T to O
-0.05	0.023-0.06	135	0.50-2.5	–	–	None	N to considerable	N to Sl.	At.		F	T to O
010	0.013	118	0.0-0.2	0.5-0.6	Slight	None	None	None	–	R	G	T
-.05	.01-.03	60-120	.01-1.0	S to SE	Slight	Slight	At.	At.	At.	Slight	G	O
-.06	.01-.03	60-120	.05-.5	S to SE	Slight	Slight	At.	At.	At.	Slight	G	O
-0.03	0.015-0.04	75-190	0.15-0.8	S to SE	None	None	None	At.	Dec.	None	F	O
.11	0.04-0.06	138	0.14	SE	None	None	Slight	None	Slight	None	G	O
-0.03	0.01-0.016	85-115	0.08-0.2	SE	None	None	Slight	None	Slight	None	Exc.	O
–	–	–	–	F	None	Swells	Swells	Swells	Swells	At. by some	–	O
-0.06	0.02-0.03	No track	0.3-0.5	S	Very Sl.	Almost N	At. only by ox. acids	Almost N	Almost N	Sol. in ket., esters, and aro. hyd.	F to Exc.	T (90-92% l.t.)
-0.05	0.02-0.03	No track	0.3-0.4	S	Very Sl.	Almost N	At. only by ox. acids	Almost N	Almost N		Exc.	T (90-92% l.t.)
–	0.012	–	0.1-0.2	SE	Very Sl.	Almost N	Almost N	Almost N	Almost N	See footnote[9]	Exc.	T (90-92% l.t.)
-0.0057	0.0005-0.0078	–	0.05-0.31	S	Sl. yel.	None	At. by ox. acids	None	None	Gasoline resistant	F to G	T (90% l.t.)
-0.0003	0.0001-0.0004	60-135	0.03-0.05	S	Sl. yel.	None	At. by ox. acids	None	None	Sol. in aromatic and chlorinated hydrocarbons	F to G	T (88-92% l.t.)
–	–	–	0.05-0.10	S	Sl. yel.	None	At. by ox. acids	R	Fair		G	TRL to O
-0.003	0.0005-0.005	60-135	0.05-0.40	S	Sl. yel.	None	At. by ox. acids	None	None		F to G	T (88-90% l.t.)
-0.02	0.0004-0.02	20-100	0.1-0.55	S	Some strength loss	None	At. by ox. acids	None	None		G	O
-0.010	0.006-0.010	100-150	0.20-0.50	S	Sl. yel.	None	At. by ox. acids	None	None	See footnote[10]	G	T
09	.009	80	0.3	S	Sl. yel.[8]	None	At. by ox. acids[6]	None	None	See footnote[11]	Exc.	TRL to O
005	0.0005	–	0.01	S	Requires black	Very R	At. slowly by ox. acids	Very R	Very R	R (below 80°C.)	Exc.	TRL to O
005	<0.0005	200-235	<0.01	S	Surface crazing (except black and brown)	Very R		Very R	Very R	Sol. in aro. solv. above 60°C.	G	TRL to O
005	<0.0005	135-160	<0.015	S		R	At. by ox. acids	R	R		F	TRL to O
24	0.010	>360	0.00	N	None	None	None	None	None	See footnote[12]	Exc.	T to TRL
03	<0.003	>200	0.005	N	None	None	None	None	None	None	Exc.	O
	0.052	–	7-14	Very L	Colors may fade	R	Dec.	Dec.	Dec.	R	G	T to O

[4]Surface resistivity decreases.
[5]Loss in surface ductility.
[6]In high concentration.
[7]Resists aliphatics; soluble in ketones, aromatics.
[8]Resists aliphatic hydrocarbons and most oils; swells in ketones, esters, and aromatic hydrocarbons; dissolves in alcohols.
[9]Slightly soluble in ethylene dichloride and some other halogenated organic solvents.
[10]Soluble in ketones, esters, and some chlorinated hydrocarbons.
[11]Variable. Attacked by ketones, esters, some halogenated solvents.
[12]Halogenated compounds cause slight swelling.

property. The manufacturers
cilitate communications with
each of these chemical types
the Directory Section. Check

O	58	61	Polectron (61)
T to O	59	32	Catalin (32)
T (90-92% l.t.)	60	6, 31, 38, 76, 107, 109	Cocor (31), CR (38), Dapon (107), Enduron (109), Laminac (6)
T to O	61	2, 5, 6, 17, 19, 20, 21, 25, 26, 33, 47, 51, 62, 64, 69, 76, 79, 89, 96, 104, 111, 121, 126, 128, 134, 136, 142, 145, 146, 150	Amester (5), Atlac (17), Bakelite (19), Cadco (26), Cellobond (25), Fostercast (150), GE (62), Glidpol (69), Glykon (64), Helix (21), Hetron (47), IC (79), Laminac (6), Loven (89), Marco (33), Paraplex (128), Plaskon (20), Pleogen (96), Polylite (121), Selectron (111), Sierracin (136), Stycast (51), Stypol (126), Synvar V (142), Vibrin (104)
T to O	62		
T	63		
O	64		
O	65	107	Dapon (107)
O	66	1, 8, 12, 14, 17, 20, 22, 39, 47, 56, 67, 68, 89, 94, 98, 106, 107, 121, 152	Acme (1), Aico (8), Aropol (14), Cordopreg (39), Dapon (107), Diall (94), Flexfirm (56), Formadall (152), Glaskyd (67), Glastic (68), Loven (89), Nureco (106), Plaskon (20), Plastrong (98), Polylite (121), Thermaflow (17), Unipreg (12)
O	67		
O	68		
O	69	23, 70	Acrylon (23), Hycar PA (70)
T (90-92% l.t.)	70	2, 22, 26, 28, 31, 63, 76, 78, 128, 130, 146, 151	Cadco (26), CO (31), Diakon (78), Fiberfil (53), Gering MMRW (65), Interplastics (80), Lucite (46), Lustreglow (145), Lustrelite (146), Lustretone (146), Perspex (78), Plexiglas (128), Sandee (130), Swirlustre (146)
T (90-92% l.t.)	71		
T (90-92% l.t.)	72	28, 46, 53, 65, 78, 80, 90, 128, 151	
T (90% l.t.)	73	61	Gafite (61)
T (88-92% l.t.)	74	6	Cymac (6)
TRL to O	75	10, 19, 22, 25, 26, 29, 32, 44, 53, 57, 60, 65, 80, 85, 90, 97, 99, 112, 130, 137, 140, 144, 151	Ampacet (10), Bakelite (19), Cadco (26), Capac (29), Catalin (32), Distrene (25), Dylene (85), Erinoid (140), Fiberfil (53), Fostarene (57), Gering PS (65), Interplastics (80), Lustrex (97), Sandee (130), Soplasco (137), Styron (44)
T (88-90% l.t.)	76		
O	77		
T	78	3, 7, 10, 16, 18, 19, 21, 22, 25, 26, 27, 29, 31, 32, 42, 43, 44, 51, 53, 57, 59, 60, 63, 65, 66, 70, 71, 72, 80, 85, 86, 90, 92, 94, 95, 97, 105, 112, 116, 117, 131, 137, 139, 140, 144, 151	Ace-Hide (7), Ampaloy (10), Ampcolite (16), Bakelite (19), Cadco (26), Campco (27), Capac (29), Catalin (32). Cerex (97), Chinatex (18), Cycolac (92), Darex (43), Distrene (25), Dylene (85), Erinoid (140), Fiberfil (53), Genco (63), Gering PSX (65), Glico (66), Good-rite (59) (70), Helix (21), Interplastics (80), Joda (42), Marbon 8000 (92), Midwest-Midlon (95), Pliolite (71), Plio-Tuf (71), Resiston (3), Riji-Tuf (7), Seilon S-3 (131), Soplasco (137), Stokoflex (139), Stokolite (139), Stycast (51), Styco (105), Styron (44)
TRL to O	79		
TRL to O	80		
TRL to O	81		
TRL to O	82		
T to TRL	83		
O	84	19, 32, 44, 151	Bakelite (19), Catalin (32), Styrex (44)
T to O	85	92, 95	Cycolac (92), Midwest-Midlon C (95)
		3, 4, 10, 13, 19, 23, 26, 27, 28, 32, 33, 44, 46, 48, 53, 63, 65, 66, 72, 74, 78, 80, 85, 86, 90, 95, 97, 99, 108, 112, 114, 130, 131, 137, 138, 145, 147, 151	Aeroflex (13), Agiline (4), Alathon (46), Alkathene (78), Bakelite (19), Boronol (3), Cadco (26), Campco (27), Catalin (32), C-I-L (28), Dow PE (44), Dylan (85), Fiberfil (53), Fortiflex (33), Genco (63), Gering PE (65), Glico (66), Hifax (74), Interplastics (80), Marlex (108), Midwest-Midlon P (95), Modulene (99), Monsanto Polyethylene (97), Petrothene (145), Plicose (114), Poly-Eth (138), Resinol (3), Sandee (130), Seilon (131), Soplasco (137), Super Dylan (85), Super Modulene (99), Tenite Polyethylene (48), Tygothene (147)
		1, 19, 46, 50, 53, 60, 65, 82, 123, 139, 144, 147, 151	Bakelite CF 3 (19), Bakelite fluorothene (19), Chemelec 500 (144), Fiberfil (53), Fluoroflex-C (123), Fluoron (139), Fluran (147), Gering KRW (65), Kel-F (82)
		28, 40, 46, 50, 60, 65, 78, 116, 117, 123, 144	Chemelec 300 (144), Chemlon (40), Fluon (78), Fluoroflex-T (123), Fluoroplast (144), Gering TRW (65), Polypenco-T (117), Teflon (46)
		11, 98	Ameroid (11), Galom (98)

117	Polypenco, Inc., 2150 Fairmont Ave., Reading, Pa.
118	Premier Thermo-Plastic Co., Middletown Road, Jeffersontown, Ky.
119	Products Research, 3126 Los Feliz Blvd., Los Angeles, Calif.
120	Raybestos-Manhattan, Inc., Manheim, Pa.
121	Reichhold Chemicals, Inc., 525 North Broadway, White Plains, N. Y.
122	Ren Plastics, Inc., 3179 S. Cedar Rd., Lansing 4, Mich.
123	Resistoflex Corp., Belleville 9, N. J.
124	Rezolin, Inc., 1651 18th St., Santa Monica, Calif.
125	Richardson Co., The, 2747 Lake St., Melrose Park, Ill.
126	Robertson Co., H.H., 2407 Farmers Bank Bldg., Pittsburgh 22, Pa.
127	Rogers Corp., Rogers, Conn.
128	Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.
129	Rostone Corp., 135 Earl Ave., Lafayette, Ind.
130	Sandee Manufacturing Co., 5050 Foster Ave., Chicago 30, Ill.
131	Seiberling Rubber Co., Plastics Div., Newcomerstown, Ohio
132	Shawinigan Products Corp., 350 Fifth Ave., New York 1, N. Y.
133	Shell Chemical Corp., 380 Madison Ave., New York 17, N. Y.
134	Sherwin-Williams Co., Chicago 28, Ill.
135	Shoe Form Co., Inc., Auburn, N. Y.
136	Sierracin Corp., Burbank, Calif.
137	Southern Plastics Co., Columbia 1, S. C.
138	Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.
139	Stokes Molded Products, Div. of Electric Storage Battery Co., Taylor St., Trenton 4, N. J.
140	Styrene Products Ltd., London W. 1, England
141	Sylvan Plastics, Inc., 350 Fifth Ave., New York 1, N. Y.
142	Synvar Corp., Wilmington 99, Del.
143	Thiokol Chemical Corp., Trenton 7, N. J.
144	United States Gasket Co., 602 N. 10th St., Camden 1, N. J.
145	U.S. Industrial Chemicals Co., Div. National Distillers Products Corp., 99 Park Ave., New York 16, N. Y.
146	U.S. Plastic Products Corp., Lake and Whitman Ave., Metuchen, N. J.
147	United States Stoneware Co., Tallmadge Ave., Akron 9, Ohio
148	Valite Corp., New Orleans 17, La.
149	Watertown Mfg. Co., Watertown, Conn.
150	Westinghouse Electric Corp., Benolite Plant, Manor, Pa.
151	Westlake Plastics Co., Lenni Mills, Pa.
152	Woodall Industries, Inc., 7565 E. McNichols Rd., Detroit 34, Mich.
153	Worbla Ltd., Papiermuehle-Berne, Switzerland

*Copyrighted 1957 by Plastics Catalogue Corp., 575 Madison Avenue, New York 22, New York. All rights reserved, including the right to reproduce the chart or portions thereof in any form. *Data compiled by Dr. Gordon M. Kline, Editorial Director, MODERN PLASTICS ENCYCLOPEDIA, and is based on information supplied by the manufacturers. Chart designed by Ugo E. Torricelli.*

PROPERTY	ROHM AND HAAS CO., Washington Square, Philadelphia 5, Pa.						FURANE PLASTICS, INC., Los Angeles 39, Calif.		
Resin number	Paraplex P-13. Flexible	Paraplex P-43, P-49. Rigid	Paraplex P-43HV. Rigid	Paraplex P-47. Semi-rigid	Paraplex P-433. Light stabilized	Paraplex P-444. Light stabilized	Lamojet	Epocast 2D 2E 2F	Epocast 17 High temp.
Identity	Polyester-styrene resin						Furan	Epoxy	
Viscosity at 25°C., cp.	340-470	2000-4500	50,000-65,000	2000-4500	5700-7500	3000-4000	200-300	2D: 3000 2E: 4000 2F: 2500	4000
Storage life of resin	Absence of light, room temp.: No catalyst: P-13, 12 mo. P-43, P-43HV, P-47, P-49, P-433, P-444, 6 mo. Refrigeration increases stability						Over 1 yr.	Over 1 yr.	6 mo.
Resin content as applied, %	50	70	80	70	75	75	100	35-60	35-60
Storage life of treated material	Room temp.: 4-7 days	Room temp.: 4-5 days					1 hr. to 1 day	Several hours	Approx. 30 days
Curing cycle Pressure, p.s.i.	Contact to 200						Contact	Contact and up	
Temperature, °F.	Start 230. 260	Start 180-200. 260					Room temp.	Room temp.	Start at 300-350 Overnight at 400
Time, min.	1-30, depending upon temperature, catalyst, thickness, type of resin, heating medium, etc.							2D: 16 hr. 2E, 2F: 20 hr.	Overnight

PROPERTY	PITTSBURGH PLATE GLASS COMPANY, Paint Division, 1 Gateway Center, Pittsburgh 22, Pa.					SHELL CHEMICAL CORP. 380 Madison Ave., N.Y., N.Y.	
Resin number	Selectron 5000 series. Rigid, general use	Selectron 5051A. Light stabilized	Selectron 5119. Room temp. curing	Selectron 5200 series. Flexible	Selectron 5400. Rigid paste resin	Epon 820, 828, 1001, 1004	Epon 815, 820, 828, 834
Identity	Unsaturated polyester resins					Epoxy resins	
						Dry lay-up	Wet lay-up
Viscosity at 25°C., cp.	50-200,000 Adjustable	2,500	625	50-2,000	Paste	Can be adjusted	500-100,000 depending on grade of resin
Storage life of resin	40°F.: over 1 yr. No catalyst in dark: 77°F.: over 4 mo. 150°F.: 5 or more days depending on resin					Room temperature: unlimited	No catalyst, room temp.: indefinite. With catalyst: 0.5-8 hr., depending on ambient temp. and type of catalyst
Resin content as applied, %	35-80	72	65	50-70	65-75	25-35	25-35
Storage life of treated material	Room temp.: 1½ hr. to 21 days with benzoyl peroxide, depending on resin type.	16 hr. at 77°F. with benzoyl peroxide	2 days at 77°F. with benzoyl peroxide	12 hr.—7 days with benzoyl peroxide	Up to 6 months at room temperature with benzoyl peroxide	Dicyandiamide at room temp.: unlimited. m-Phenylenediamine and Curing Agent Z at room temp.: 2-3 wk.; at 40°F.: 6 mo.	1-8 hr., depending on curing agent
Curing cycle Pressure, p.s.i.	Preform: 0-300 / Premix: 50-2000	Contact to 300				Contact and up	Contact and up
Temperature, °F.	140-250 / 325 max.	140-250 depending on catalyst	Room to 180	180-250	200-300	Dicyandiamide: 345. m-Phenylenediamine and Curing Agent Z: 225-350	60-350, depending on curing agent
Time, min.	1-5 / ½-3	1-5	10 min. to 48 hr. depending on system used	15-60	2-30	Dicyandiamide: 30. m-phenylenediamine and Curing Agent Z: 5-30	10-60, up to 2 days for 60-80° F. curing.

PROPERTY	SYNCO RESINS, INC., Bethel, Conn.				SYNVAR CORP., Wilmington 99, Del.			
Resin number	Synco 269	Synco 274	Synco 4180	Synco 350	Synvaren LP	Synvaren 621	Synvaren 9203	Synvaren 9205, 9207
Identity	Modified phenolic resin	Phenolic resin	Modified phenolic resin	Phenolic resin	Straight phenolic resin			Modified phenolic resin
Viscosity at 25°C., cp.	250-280	195-315	145-245	100-250	300-500	8000-10,000	200-300	300-500
Storage life of resin	Below 50°F.: 6 months minimum				6 months to 1 year		6 mo.	6 mo. min.
Resin content as applied, %	30-50				30-50			30-50
Storage life of treated material	Room temp.: 3-12 months		Synco 4180: indefinitely long shelf life		4-6 months			Up to 6 mo.
Curing cycle Pressure, p.s.i.	50 and up				50 and up			50 and up
Temperature, °F.	280-310				300 and up			275-350
Time, min.	Varies with thickness				Depends on conditions			

PROPERTY	REICHHOLD CHEMICALS, RCI Building, White Plains, N.Y.								
Resin number	Plyophen 169, 5013, 5025, 5592	Polylite 8000, 8001, 8009 General purpose	Polylite 8100, 8016 General purpose, light-stabilized	Polylite 8027, 8037, 8237 & 8173 (resilient) Surfacing resins, non-air inhibited	Polylite 8050 High heat resistant	Polylite 8061, 8065 Self-extinguishing	Polylite 8005-LV, 8007-LV General purpose, low viscosity	Polylite 8120, 8150 Flexible	Polylite 8166, 8170, 8171, 8180, and 8181 (vinyltoluene)
Identity	Phenolic resin	100% polymerizable unsaturated polyester styrene resins							
Viscosity at 25°C., cp.	169: 80-160 5013: 40-75 5025: 150-400	320-3650	8016: 3650 8100: 2200	320-1900 8027: thixotropic	2800	1290-2270	65-100	285-1180	575-2700
Storage life of resin	Below 70°F.: 2 mo. Below 50°F.: 6 mo.	40°F.: Over 1 year No catalyst in dark: 77°F.: 3-6 mo. 100°F.: 3-4 weeks							
Resin content as applied, %	60-70	60-72	70-72	60-65	70-72	65-72	48-52	54-80	60-72
Storage life of treated material	Room temp.: 4-6 mo.	From a few minutes to as much as six months, depending on type of resin, catalyst or catalyst-accelerator system, and storage temperature							
Curing cycle Pressure, p.s.i.	169, 5025 & 5592: 15 & up 5013: 50 & up	From contact on hand layup to 300 on preform molding and 50 to 2000 on premix molding							
Temperature, °F.	169, 5025: 275-325 5013 & 5592: 300-325	Room temperature to 200 on hand layup; 180 to 280 on matched die molding; 225-325 on premix molding							
Time	169 & 5025: 325°F.: 1/8": 3 min. 275°F.: 1/8": 20 min. 5013: 1/8": 10-12 min. 5592: 1/8": 20 min.	Hot cures: 1 to 30 min. Cold cures: 30 min. to 10 hr.		Depending on resin, catalyst system used, mass, and curing conditions					

PROPERTY	REICHHOLD CHEMICALS, RCI Building, White Plains, N.Y.				BARRETT DIV., ALLIED CHEMICAL AND DYE CORP.			
Resin number	Polylite 8200, 8202, 8217 General purpose, thixotropic	Polylite 8055 General purpose	Polylite 8400	Polytool 6125, 6130, 6140	Plaskon 911	Plaskon 920	Plaskon 941	Plaskon 951
Identity	100% polymerizable unsaturated polyester styrene resins	Vinyl toluene	Rigid, high heat distortion diallyl phthalate	Epoxy resins	Rigid; high heat distortion; diallyl phthalate	Rigid; high heat distortion; diallyl phthalate	General purpose; rigid; styrene	General purpose; rapid impregnating; styrene
Viscosity at 25°C., cp.	575-1900	370	150,000-180,000	500-19,000 (adjustable)	165,000 at 30°C.	10,000	700	330
Storage life of resin	No catalyst in dark: 40°F.: Over 1 year; 77°F.: 3-6 mo.; 100°F.: 3-4 weeks		No catalyst in dark: 77°F.: 6-12 mo.	Room temp.: unlimited	12 mo. at 70°F. in the dark		6 mo. at 70°F. in the dark	
Resin content as applied, %	60-62	60-65	27-29	25-100	—			
Storage life of treated material	From a few minutes to as much as six months, depending on type of resin, catalyst or catalyst-accelerator system, and storage temperature			20 min. to several hours with some hardeners; to unlimited with other types	2 da. at 70°F. in the dark		5 da. at 70°F. in the dark	14 da. at 70°F. in the dark
Curing cycle Pressure, p.s.i.	From contact on hand layup to 300 on preform molding and 50 to 2000 on premix molding			Contact and up	Contact and up			
Temperature, °F.	Room temperature to 200 on hand layup; 180 to 280 on matched die molding; 225-325 on premix molding			Room temp. to 350 depending on curing agent	180-250	180-250	Depends on catalyst accelerator system	
Time	Hot cures: 1 to 30 min. Cold cures: 30 min. to 10 hr.		Depending on resin, catalyst system used, mass, and curing conditions	Hot cures: 10-60 min. Cold cures: From less than 2 to 4 hours depending on hardener.	1-30 min.	1-30 min.	Depends on catalyst accelerator system	

PROPERTY	BARRETT DIV., ALLIED CHEMICAL AND DYE CORP., 40 Rector St., New York 6, N.Y.							
Resin number	Plaskon 9404	Plaskon 9411	Plaskon 9441	Plaskon 942	Plaskon 9500	Plaskon 9510	Plaskon 9511	Plaskon 9600
Identity	Rigid; light stable; styrene	Rigid; medium viscosity; styrene	Rigid; light stable; styrene	General purpose; rigid; styrene	Resilient; high impact; styrene	Resilient; medium viscosity; styrene	Resilient; low viscosity; styrene	Flexible; high impact; high elongation; styrene
Viscosity at 25°C., cp.	2200	2700	2200	2200	800	2700	800	1000
Storage life of resin	4 mo. at 70°F. in the dark			6 mo. at 70°F. in dark	4 mo. at 70°F. in the dark			
Storage life of treated material	4 da. at 70°F. in the dark			7 da. at 70°F. in the dark	4 da. at 70°F. in the dark			7 da. at 70°F. in the dark
Curing cycle Pressure, p.s.i.	Contact and up							
Temperature, °F.	Depends on catalyst-accelerator system							
Time	Depends on catalyst-accelerator system							

PROPERTY	NAUGATUCK CHEMICAL, Div. of U.S. Rubber Co., Naugatuck, Conn.								
Resin number	Vibrin 114, 117, 152 General purpose	Vibrin 151 Semi-rigid automotive	Vibrin 152-LS-4 Light stable	Vibrin 121 Flexible	Vibrin 153 Compounded for boat covering	Vibrin 154 Compounded for hand lay-up	Vibrin 115A, 156 Matched die and premix molding. High heat distortion	Vibrin X1088 Matched die molding and potting. Low shrinkage	Vibrin 135 (X-1047) Super-heat resistant
Identity	Unsaturated polyester-styrene resins								Triallyl cyanurate type
Viscosity at 25°C., cp.	400 to 2500 depending on resin	300 to 400	2500	60	Thixotropic	Thixotropic	1000 (115A) 2500 (156)	600-2500	2500
Storage life of resin	No catalyst, 70°F., dark: 1 yr. Refrigerated: indefinitely.								
Resin content as applied, %	35 to 75								
Storage life of treated material	1.5% benzoyl peroxide —>48 hr. Refrigerated - 1 wk. to 1 month				10 min. and up				>48 hr. at 77°F.
Curing cycle Pressure, p.s.i.	Contact to 300								
Temperature, °F.	Matched metal die molding and press cures 200-250. Also room temp. curing with promoters								
Time, min.	1.5 up according to temp., resin, and conditions								

PROPERTY	AMERICAN ALKYD INDUSTRIES, Broad and 14th St., Carlstadt, N.J.								
Resin number	Amester 502	Amester 552	Amester 722	Amester 722 L.S.	Amester 722 L.V.	Amester 822	Amester 852	Amester 922	Amester 1022
Identity	Rigid: Reactive polyester	Rigid: Matched metal polyester	Rigid: General purpose polyester	Rigid: Light stable polyester	Rigid: Low viscosity polyester	Rigid: Thixotropic polyester	Rigid: Fire retardant polyester	Flexible polyester	Gel coat polyester
Viscosity at 25°C., cp.	1600	1100	600	600	75	Thixotropic	3000	250	Thixotropic
Storage life of resin at 77°F.	4 mo.	4 mo.	6 mo.	6 mo.	6 mo.	6 mo.	6 mo.	6 mo.	6 mo.
Resin content as applied, %	73	73	70	70	60	73	75	75	70
Storage life of treated material	1% Benzoyl peroxide—2-5 days								
Curing cycle Pressure, p.s.i.	Contact and up								
Temperature, °F.	Room temperature to 280 depending on type and concentration of catalyst and promoter								
Time, min.	1 minute and up depending on temperature, pressure, catalyst, promoter and resin mass								

PROPERTY	DUREZ PLASTICS DIV., HOOKER ELECTROCHEMICAL CO., North Tonawanda, N.Y.							
Resin number	Hetron 93LS Light stabilized	Hetron 92 Rigid, general use	Hetron 32A Semi-rigid, automotive matched die molding	Hetron 31 Semi-rigid, tough, molding, potting	Hetron 72 Rigid, chemical resistant, high heat distortion	Hetron 73 Rigid, high heat distortion	Hetron 32ALS Semi-rigid, light stabilized, structural	Hetron 42 Flexible, not self-extinguishing
Identity	Unsaturated polyesters, styrene monomer. (All self-extinguishing except Hetron 42)							
Gardner viscosity 23°C., cp.	550-630	1300-1800	1300-1800	900-1100	1300-1800	2300-2700	1300-1800	1300-1800
Storage life of resin	3 months	(a) In dark, 70°F., 3 months to 6 months; (b) 158°F.: >4 days						
Resin content as applied, %	60 to 80							
Storage life of treated material	1% benzoyl peroxide, at 73°F.: 48 hours							
Curing cycle Pressure, p.s.i.	Contact up to 500, not air-inhibited							
Temperature, °F.	60 to 300 depending on catalyzation and time							
Time, min.	30 seconds to several days depending on catalyzation and temperature							

PROPERTY	BAKELITE CO., DIV. OF UNION CARBIDE AND CARBON CORPORATION, 30 E. 42nd Street, New York 17, N.Y.				DUREZ PLASTICS DIV., HOOKER ELECTRO-CHEMICAL CO., North Tonawanda, N.Y.	DOW CORNING CORP., Midland, Mich.		GENERAL ELECTRIC CO. (See also p. 590)	PLASTICS ENGINEERING CO., Sheboygan, Wis.
Resin number	Bakelite BLL-3085, 3238, 3526 BLSA-3005 8946	Bakelite PLL-3136, 4262, 4264, 5003, 5141, 5142, 5147, 5193, 5203	Bakelite ERL-2774 ERL-2795 ERL-3794	Bakelite ERL-2774, EKR-2002, EKS-2002, EKR-2003, ELS-3001	Durez 12120 16044	DC 2104	DC 2106	GE 12304 GE 12389	Plenco 204 205
Identity	Phenolic resin	Unsaturated polyester resin	Epoxy resin. Wet lay-up	Epoxy resin. Dry lay-up	Phenolic resin	Silicone resin		Phenolic	Phenolic resin
Resin or resin formers, %	3238: 73-78 3085: 59-64 3005: 60-64 3526: 63½-67½	100	100	100	70 as shipped 16044: 60-65	60	60	70	204: 71-74 205: 67-70
Viscosity at 25°C., cp.	3238: 1600-2200 3085: 125-175 3005: 210-250 3526: 210-340	From 60 to 3500	500-19,500	Can be adjusted.	300-500 Can be adjusted	20 to 40	30 to 50	12304: 200-300 12389: 150-200	204: 400-600 205: 250-400
Solvents	Ethyl alcohol, alcohol and water mixtures	Ketones, Cellosolve	Ketones, esters, aromatics and alcohol-ethers	Ketones, esters, aromatics, and alcohol-ethers	Ethyl or isopropyl alcohol	Toluene or naphthas of b.p. < 200 °F.		Ethyl or isopropyl alcohol	Ethyl or isopropyl alcohol
Storage life of resin	3238, 3005, 8946- Below 70 °F.- 60 days. Below 50 °F.- 6 mo. 3005, 3526- Below 50 °F.- 3 mo.	No catalyst in dark at 70 °F.: 3 to 6 mo.	No hardener, room temperature: indefinite	Room temperature, unlimited	Room temp.: 1 mo. Below 50 °F.: 3 mo.	No catalyst: > 6 mo.		Below 75 °F.: 60 days	Below 75 °F.: 2 mo.
Resin content as applied, %	3238: 35-60 3085: 28-44 3005: 28-44 3526: 35-60	25 to 80	25-75	25-35	30 to 50	60	60	30-50	30-50
Catalysts	Can be accelerated by 1% NaOH or hexamethylene tetramine	0.5-2.0% of various peroxides such as benzoyl or methyl ethyl ketone peroxide	22½ p.p.h. ZZL-0812 37½ p.p.h. ZZL-0803 25 p.p.h. ERL-2793 28½ p.p.h. ZZLA-0800	22½ p.p.h. ZZL-0812 37½ p.p.h. ZZL-0803 25 p.p.h. ERL-2793 28½ p.p.h. ZZLA-0800	–	DC XY-5 10-25 cc./gal.	DC XY-15 0.1 to 0.3%	None necessary	–
Inhibitors	Acids to narrow pH range	Copper, antioxidants	None	None	–	Acids		–	–
Impregnation apparatus	Dip tank with squeeze rolls or scraper bars	Squeeze rolls, knife coating, brush, pour-on	Pour-on, knife coating, brush, squeeze rolls	Air tank with rolls or bars	Conventional dip tank	Dip tank, hot-air curing oven		Dip tank with or without squeeze rolls	Conventional dip tank with squeeze rolls or scraper bars
Preparation of resin	Thin resin to viscosity desired for treating	Add catalyst. Agitate thoroughly to dissolve	Add hardener or catalyst, agitate at room temperature	Add hardeners or catalyst, agitate at room temperature.	Adjust to desired viscosity and solids content with alcohol	Add catalyst and agitate thoroughly. Apply to heat-cleaned cloth		Thin if necessary to obtain proper resin pick-up	Thin to desired viscosity and solids content with alcohol
Drying	3238, 8946: 2 to 7 min. at 285 °F. 3085, 3005, 3526: 5 to 6 min. at 260-280 °F.	–	–	–	Start at 200 °F. Raise to 250-275 °F. Adjust to give required volatile content	Precure for 5-10 min. at 230 °F. Special postcure cycles for electrical and high temperature uses		Dry at 250-275 °F. Adjust speed to give required flow in material	250-295 °F. Adjust speed for desired volatile content
Storage life of treated material	Room temp.: 2 mo.	1% Benzoyl peroxide: 2 days to 2 wk. No catalyst at 70 °F.: 3 to 6 mo.	½ to 6 hr.	Methyl dibenzyl amine at room temp. (for ELS-3001) unlimited. Methylene dianilene at room temp. 1-4 weeks: at 40 °F., 3-6 mo.	Below 75 °F.: Up to 6 mo.	Resin solution with catalyst: 24 hr. at 77 °F. Coated fabric: 6 mo. at 77 °F.	Resin solution with catalyst: 30 da. at 77 °F. Coated fabric: 6 mo. at 77 °F.	Room temp.: 2 mo.	Room temp.: 2 mo.
Curing cycle Pressure, p.s.i.	3238: 50-300 3085, 3005: 14-300 3526: 50-300	Contact and up	Contact to 300	Contact and up	60-100. 16044: contact and up	3-30	15-200	15 and up	100 and up
Temperature, °F.	240 to 360	Mold or platen temperature 160-280 Room temperature also	Room to 325	300-350	340 Heat supplied on one side	347	347	320-330	300-330
Time, min.	1/8" 3238: 10-15 3085, 3005: 30-60 3526: 30-50	1 to 10 for heated mold. 1 hr. to 10 hr. at room temperature	10 to 60	30-60	0.05" to 0.10": 10-15	1/8": 15-30 1/4": 30-60 1/2": 60	1/8": 15-30 1/4": 30-60 1/2": 60	1/8": 30	1/8": 10-30

Plasticizers Chart

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25°C.	R. I. AT 25°C.	F. P. °C.	V. P. mm. Hg
Abietic acid derivatives							
1. Hydroabietyl alcohol	$C_{19}H_{31}CH_2OH$	$C_{20}H_{34}O$	290	1.008	1.526°	185	1.5×10^{-4} @25°
2. Methyl abietate	$C_{19}H_{29}COOCH_3$	$C_{21}H_{32}O_2$	316	1.033	1.529°	180	<0.1@25°
3. Hydrogenated methyl abietate	$C_{19}H_{31}COOCH_3$	$C_{21}H_{34}O_2$	318	1.026	1.519°	180	<0.1@25°
Adipic acid derivatives							
4. Diethyl adipate	$C_2H_5OCO(CH_2)_4COOC_2H_5$	$C_{10}H_{18}O_4$	202	1.002	1.426	–	–
5. Dibutyl adipate	$C_4H_9OCO(CH_2)_4COOC_4H_9$	$C_{14}H_{26}O_4$	258	0.961	1.434	116	–
6. Diisobutyl adipate	$[CH_2CH_2COOCH_2CH(CH_3)_2]_2$	$C_{14}H_{26}O_4$	258	0.950°	1.4293	160	–
7. Di-*n*-hexyl adipate	$C_6H_{13}OCO(CH_2)_4COOC_6H_{13}$	$C_{18}H_{34}O_4$	314	0.925-0938°	1.4125°	–	–
8. Dicapryl adipate	$C_8H_{17}OCO(CH_2)_4COOC_8H_{17}$	$C_{22}H_{42}O_4$	371	0.9135°	–	–	–
9. Di-(2-ethylhexyl) adipate	$C_4H_8[COOCH_2CH(C_2H_5)C_4H_9]_2$	$C_{22}H_{42}O_4$	371	0.9268°	1.4466	194	<0.01
10. Di-isooctyl adipate	$C_8H_{17}OCO(CH_2)_4COOC_8H_{17}$	$C_{22}H_{42}O_4$	371	0.928° 0.924°	1.448 1.445	210 195	<0.12@150°
11. Dinonyl adipate	$(CH_2)_4(COOC_9H_{19})_2$	$C_{24}H_{46}O_4$	399	0.9168°	–	232	–
12. Octyl decyl adipate (Isooctyl decyl adipate)	$C_8H_{17}OCO(CH_2)_4COOC_{10}H_{21}$	$C_{24}H_{46}O_4$	399	0.914-0.924	1.446-1.4505	200-235	<0.04@150°
13. Di-decyl adipate (Di-isodecyl adipate)	$C_{10}H_{21}OCO(CH_2)_4COOC_{10}H_{21}$	$C_{26}H_{50}O_4$	427	0.915-0.918	1.4498-1.4508	219-227	–
14. Polypropylene adipate modified	–	–	–	1.05°	1.452°	–	–
15. Dimethoxyethyl adipate	$CH_3OC_2H_4OCO(CH_2)_4COOC_2H_4OCH_3$	$C_{12}H_{22}O_6$	262	1.075	1.439	–	–
16. Diethoxyethyl adipate	$C_2H_5OC_2H_4OCO(CH_2)_4COOC_2H_4OC_2H_5$	$C_{14}H_{26}O_6$	290	1.036	1.439	–	–
17. Dibutoxyethyl adipate	$(C_4H_9OC_2H_4OCOCH_2CH_2)_2$	$C_{18}H_{34}O_6$	346	0.997°	1.442	188	<0.17@150°
18. Dihexoxyethyl adipate	$(CH_2)_4(COOC_2H_4OC_6H_{13})_2$	$C_{22}H_{42}O_5$	402	0.9642	1.4440	–	–
19. Dibutoxyethoxy ethyl adipate	$[C_4H_9OC_2H_4OC_2H_4COO(CH_2)_2]_2$	$C_{22}H_{42}O_8$	435	1.025	1.447	166	–
20. Di(methylcyclohexyl) adipate	$CH_3C_6H_{10}OCO(CH_2)_4COOC_6H_{10}CH_3$	$C_{20}H_{34}O_4$	338	1.007	1.468	190	1.95@200°C.
21. Dibenzyl adipate	$C_6H_5CH_2OCO(CH_2)_4COOCH_2C_6H_5$	$C_{20}H_{22}O_4$	326	–	–	–	–
22. Ditetrahydrofurfuryl adipate	$(C_4H_7O.CH_2OCOCH_2CH_2)_2$	$C_{16}H_{26}O_6$	314	–	–	–	–
Azelaic acid derivatives							
23. Di-2-ethylbutyl azelate	$C_6H_{13}OCOC_7H_{14}COOC_6H_{13}$	$C_{21}H_{40}O_4$	356	0.934°	1.4445	185	–
24. Di-2-ethylhexyl azelate	$C_8H_{17}OCOC_7H_{14}COOC_8H_{17}$	$C_{25}H_{48}O_4$	413	0.9184°	1.4464	212	–
25. Di-isooctyl azelate	$C_8H_{17}OCOC_7H_{14}COOC_8H_{17}$	$C_{25}H_{48}O_4$	413	0.918-0.920°	1.448-1.450	213-219	–
Benzoic acid derivatives							
26. Ethylene glycol dibenzoate	$C_6H_5COOCH_2CH_2OCOC_6H_5$	$C_{16}H_{14}O_4$	270	–	–	–	–
27. Diethylene glycol dibenzoate	$C_6H_5CO(OCH_2CH_2)_2OCOC_6H_5$	$C_{18}H_{18}O_5$	314	1.178 1.1765°	1.5424 1.5449°	–	<0.01
28. Dipropylene glycol dibenzoate	$C_6H_5CO(OC_3H_6)_2OCOC_6H_5$	$C_{20}H_{22}O_5$	342	1.129 1.1260°	1.5282 1.5300°	–	1.2@200°
29. Triethylene glycol dibenzoate	$C_6H_5CO(OCH_2CH_2)_3OCOC_6H_5$	$C_{20}H_{22}O_6$	358	1.168	–	–	–
30. Polyethylene glycol (200) dibenzoate	$C_6H_5CO(OCH_2CH_2)_nOCOC_6H_5$	–	408	1.158	1.5252	–	–
31. Polyethylene glycol (300) dibenzoate	$C_6H_5CO(OCH_2CH_2)_nOCOC_6H_5$	–	508	1.150	1.5137	–	–
32. Polyethylene glycol (400) dibenzoate	$C_6H_5CO(OCH_2CH_2)_nOCOC_6H_5$	–	608	1.145	1.5077	–	–
33. Polyethylene glycol (600) dibenzoate	$C_6H_5CO(OCH_2CH_2)_nOCOC_6H_5$	–	808	1.141	1.4984	–	–
34. **Benzophenone**	$C_6H_5COC_6H_5$	$C_{13}H_{10}O$	182	1.0976@50°	1.5975@45°	–	–
Biphenyl derivatives							
35. 2-Nitrobiphenyl	$C_6H_5C_6H_4NO_2$	$C_{12}H_9O_2N$	199	1.203	1.612	143	–

*Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS		MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA			
	°C.	°C.	% by wt.													
1.	–	32-33	Ins.	I	I	C	C	P	I	I	P	C	P	Abitol (38)		38
2.	310@760 mm.[e]	–	Ins.	I	P	C	C	C	C	I	C	C	C	Abalyn (38)		38
3.	350@760 mm.[e]	–	Ins.	I	P	C	C	C	C	I	C	C	C	Hercolyn (38)		38
4.	245	−14	0.060	C	C	C	–	–	–	–	–	–	–	—		10, 22
5.	168-170@17 mm.	–	Ins.	P	C	C	C	–	–	C	C	C	C	—		35
6.	135-147@4 mm.	−20	Ins.	–	C	C	–	–	–	C	–	C	C	"Cabflex Di-BA" (12) "Darex" DIBA (20)	"Kesscoflex" DIBA (45) "Staflex" DI-BA (19)	12, 19, 20, 26, 35, 45, 54
7.	204-206@8 mm.	−8	0.025[e]	P	C	C	C	C	C	P	P	C	C	"Kesscoflex" DHA (45)		35, 45
8.	213-217@4 mm.	−15	Ins.	C	C	C	C	C	C	P	P	C	C	"Harflex" 280 (35)		35
9.	210-218@5 mm.	<−75	<0.01	P	C	C	C	P	C	P	P	C	C	"Adipol" 2EH (54) "Cabflex" DOA (12) DOA 775 (58) "Elastex" 60-A (11) "Flexol" A-26 (14) "Good-rite" GP-233 (33) "Kesscoflex" DOA (45)	"Kolflex" DOA (46) "Morflex" 310 (49) "Plastomoll" DOA (9) "Polycizer" 332 (36) "PX"-238 (57) "Staflex" DOA (19)	9, 11, 12, 14, 19, 26, 33, 34, 35, 36, 37, 45, 46, 47, 49, 50, 54, 57, 58, 60
10.	205-220@4 mm.	<−70	Ins.	P	C	C	C	C	C	C	P	C	C	"Adipol" 10A (54) "Cabflex Di-OA" (12) "Darex" DIOA (20) "Good-rite" GP-233 (33) "Harflex" 220 (35)	"Kesscoflex" DIOA (45) "Morflex" 300 (49) "PX"-208 (57) "Staflex" DIOA (19) "Witcizer" 412 (70)	11, 12, 19, 20, 33, 34, 35, 37, 45, 49, 50, 54, 57, 60, 70
11.	–	−65	Ins.	P	C	–	C	C	C	–	–	C	C	"Morflex" 390 (49) "Plastomoll" NA (9)	"PX"-209 (57)	9, 35, 49, 50, 57
12.	210-232@4 mm.	<−60	Ins.	P	C	C	C	P	C	C	P	C	C	"Adipol" ODY (54) "Adipol" 810 (54) "Cabflex" ODA (12) "Good-rite" GP-235 (33) "Hercoflex" 290 (38) "Kesscoflex" ODA (45)	"Morflex" 375 (49) ODA 778 (58) "Polycizer" 532 (36) "PX"-218 (57) "Staflex" ODA (19)	12, 19, 33, 35, 36, 38, 45, 49, 54, 57, 58, 60
13.	238-246@4 mm.	−72	Ins.	P	C	C	C	P	C	C	I	C	C	"Adipol" XX (54) "Cabflex" DDA (12) "Darex" DIDA (20) DDA 777 (58) "Elastex" 20-A (11) "Flexol" 10-A (14) "Good-rite" GP-236 (33)	"Kesscoflex" IDA (45) "Kolflex" DDA (46) "Morflex" 330 (49) "Polycizer" 632 (36) "PX"-220 (57) "Staflex" DDA (19)	11, 12, 14, 19, 20, 33, 35, 36, 37, 45, 46, 47, 49, 54, 57, 58, 60
14.	–	<−20	Ins.	–	–	–	–	–	–	–	–	C	C	"Hexaplas" PPL (41)		13, 41
15.	185-190@11 mm.	−16	1.420	C	C	C	–	–	–	–	–	–	–	"Kesscoflex" MCA (45)		22, 45
16.	165@4 mm.	<−70	0.248	C	C	C	–	–	–	–	–	–	–	–		22
17.	208-215@4 mm.	−34	0.08	P	C	C	C	C	C	P	C	C	C	"Adipol" BCA (54) DBEA 779 (58) "Kesscoflex" BCA (45)	"Plastoflex" 3 (1) "Staflex" DBEA (19)	1, 19, 37, 45, 54, 58
18.	–	−6	–	–	–	–	–	–	–	–	–	–	–	–		19
19.	240-260@1-3 mm.	–	0.3	I	I	C	C	–	–	C	C	–	–	TP-95 (67)		67
20.	190-200@3 mm.	–	Ins.	C	C	C	C	P	C	C	C	C	C	"Sextol" adipate (40)		40
21.	–	–	Ins.	–	–	–	–	–	C	–	–	C	C	"Morflex" 350 (49)		35, 49
22.	200-207@1.5 mm.	5-15	Ins.	–	C	–	–	–	–	–	–	–	–	–		22
23.	230@5 mm.	−65	Ins.	C	C	C	C	–	–	P	I	C	C	"Plastolein" 9050 DHZ (27)		27
24.	237@5 mm.	−65	Ins.	C	C	C	C	–	–	P	I	C	C	"Cabflex" DOZ (12) "Kesscoflex" DOZ (45) "Morflex" 410 (49)	"Plastolein" 9058 DOZ (27) "Staflex" DOZ (19)	12, 19, 26, 27, 34, 45, 49, 57
25.	225-244@4 mm.	−65	Ins.	C	C	C	C	–	–	P	I	C	C	"Cabflex" Di-OZ (12) "Kesscoflex" DIOZ (45)	"Morflex" 400 (49) "Plastolein" 9057 DIOZ (27)	12, 26, 27, 45, 49
26.	–	70-72	Ins.	P	C	C	C	–	C	C	C	C	C	"Benzoflex" E-60 (66)		66
27.	230-242@5 mm.	16-28	<0.01	P	C	C	C	C	C	C	C	C	C	"Benzoflex" 2-45 (66)	"Plastoflex" DGB (1)	1, 66
28.	225-235@5 mm. 250@10 mm.	<−35 −12	<0.01	P	C	C	C	C	C	C	C	C	C	"Benzoflex" 9-88 (66) "Flexol" 77-G (14)	"Plastoflex" MGB (1)	1, 14, 66
29.	223-237@1 mm.	47	0.05	P	C	C	C	–	C	C	C	C	C	"Benzoflex" T-150 (66)		66
30.	217-290@1 mm.	<−35	0.08	I	C	C	C	–	C	C	C	C	C	"Benzoflex" P-200 (66)		66
31.	243-327@1 mm.	<−35	0.14	I	C	C	C	–	C	C	C	C	C	"Benzoflex" P-300 (66)		66
32.	258 d.@1 mm.	<−35	0.70	I	C	C	C	–	C	C	C	C	C	"Benzoflex" P-400 (66)		66
33.	200 d.@1 mm.	3.8	0.78	I	C	C	C	–	C	C	C	C	C	"Benzoflex" P-600 (66)		66
34.	305	48	0.006	C	C	–	–	–	–	–	–	–	–	–		22, 29, 43, 52
35.	320-330	34.5	Ins.	C	C	C	C	–	C	C	C	C	C	Ortho-nitrobiphenyl ONB (47)		47

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25° C.	R. I. AT 25° C.	F. P. °C.	V.P. mm. Hg
36. Chlorinated biphenyl	–	–	–	1.182–1.192	1.617–1.618	141–150	–
37. Chlorinated biphenyl	–	–	–	1.270–1.280	1.620–1.622	152–154	–
38. Chlorinated biphenyl	–	–	–	1.378–1.388	1.627–1.629[c]	176–180	–
39. Chlorinated biphenyl	–	–	–	1.447–1.457	1.630–1.631[c]	193–196	–
40. Chlorinated biphenyl	–	–	–	1.538–1.548	1.637–1.639[c]	None	–
41. Chlorinated biphenyl	–	–	–	1.577–1.587	1.6501–1.6517	None	–
42. Chlorinated biphenyl	–	–	–	1.618–1.629	–	None	–
43. Chlorinated biphenyl	–	–	–	1.810	–	None	–
44. Chlorinated polyphenyl	–	–	–	1.670	1.664–1.667	None	–
45. Chlorinated polyphenyl	–	–	–	1.470	–	247	–
46. Chlorinated polyphenyl	–	–	–	1.670	1.660–1.665	None	–
47. Chlorinated polyphenyl	–	–	–	1.734	–	None	–
48. **Camphor**	$CH_2CH_2CHC(CH_3)_2C(CH_3)COCH_2$	$C_{10}H_{16}O$	152	0.990	–	93	38 @ 18°
Caprylic acid derivative							
49. Butanediol dicaprylate	$(CH_2)_2(CH_2OCOC_7H_{15})_2$	$C_{26}H_{50}O_4$	342	0.929[c]	1.4420	–	–
Citric acid derivatives							
50. Triethyl citrate	$(C_2H_5OCOCH_2)_2C(OH)COOC_2H_5$	$C_{12}H_{20}O_7$	276	1.136	1.4405 @ 24.5°	155	–
51. Tri-*n*-butyl citrate	$(C_4H_9OCOCH_2)_2C(OH)COOC_4H_9$	$C_{18}H_{32}O_7$	360	1.049 @ 20°	1.4453[c]	185	–
52. Acetyl triethyl citrate	$(C_2H_5OCOCH_2)_2C(OCOCH_3)COOC_2H_5$	$C_{14}H_{22}O_8$	318	1.135 @ 23°	1.4386 @ 23°	188	–
53. Acetyl tri-*n*-butyl citrate	$(C_4H_9OCOCH_2)_2C(OCOCH_3)COOC_4H_9$	$C_{20}H_{34}O_8$	402	1.046	1.4408 @ 25.5°	204	–
54. Acetyl trihexyl citrate	$(C_6H_{13}OCOCH_2)_2C(OCOCH_3)COOC_6H_{13}$	$C_{26}H_{46}O_8$	487	1.005	1.4453 @ 26°	230	–
55. Acetyl tri-(2-ethylhexyl)citrate	$(C_8H_{17}OCOCH_2)_2C(OCOCH_3)COOC_8H_{17}$	$C_{32}H_{58}O_8$	571	0.983	1.441	224	–
Coconut oil derivatives							
56. Chlorinated coconut oil fatty acids	–	–	320	1.13	1.480	145	–
Epoxy derivatives							
57. Epoxy-type plasticizer	–	–	354	0.910[c]	1.451	210	0.06 @ 150°
58. Epoxy-type plasticizer	–	–	–	0.991–0.994	1.471	232	–
59. Epoxy-type plasticizer	–	–	–	0.901	1.453	207	–
60. Epoxy-type plasticizer	–	–	>350	0.910	1.451	200	–
61. Epoxy-type plasticizer	–	–	>950	0.994	1.472	310	–
62. Epoxy-type plasticizer	–	–	960	0.991	1.471	310	–
63. Epoxy-type plasticizer	–	–	–	0.92	1.4590	220	–
64. Epoxy-type plasticizer	–	–	–	0.909	1.452	–	–
65. Epoxy-type plasticizer	–	–	380	0.901	1.452	202	–
66. Alkyl epoxy stearate	$C_8H_{17}CH\text{-}O\text{-}CH(CH_2)_7COOR$	–	–	0.89	1.4525	204	–
Ether derivatives							
67. Dibenzyl ether	$(C_6H_5CH_2)_2O$	$C_{14}H_{14}O$	198	1.0428[c]	–	–	–
68. Bis(dimethyl benzyl)ether	$[(CH_3)_2C_6H_3CH_2]_2O$	$C_{18}H_{22}O$	254	1.008[c]	1.553	188	0.6
Ethylhexoic acid derivative							
69. 2.2′-(2-Ethylhexamido) diethyl di-(2-ethylhexoate)	$(C_7H_{15}COOC_2H_4)_2NCOC_7H_{15}$	$C_{39}H_{53}NO_5$	484	0.9564[c]	1.4584[c]	216	<0.01
Fumaric acid derivative							
70. Diphenoxyethyl fumarate	$(C_6H_5OC_2H_4OCO)_2C_2H_2$	$C_{20}H_{20}O_6$	356	1.08	–	–	–
Glycerol derivatives							
71. Glycerol monoacetate	$CH_2COOCH_2CHOHCH_2OH$	$C_5H_{10}O_4$	134	1.190	1.4535	148	–
72. Glycerol diacetate	$C_3H_5(OH)(OCOCH_3)_2$	$C_7H_{12}O_5$	176	1.186[c]	–	146	–
73. Glycerol triacetate	$CH_2COOCH_2CH(OCOCH_3)CH_2OCOCH_3$	$C_9H_{14}O_6$	218	1.160	1.429	133	–
74. Glycerol tripropionate	$C_3H_5(OCOC_2H_5)_3$	$C_{12}H_{20}O_6$	260	1.078[c]	1.431[c]	–	–
75. Glycerol tributyrate	$C_3H_5(OCOC_3H_7)_3$	$C_{15}H_{26}O_6$	302	1.035[c]	1.4359[c]	–	–
Glycol derivatives							
76. Ethylene glycol dipropionate	$(CH_2OCOC_2H_5)_2$	$C_8H_{14}O_4$	174	1.054 @ 15°	1.419	–	–
77. Ethylene glycol dibutyrate	$(CH_2OCOC_3H_7)_2$	$C_{10}H_{18}O_4$	202	1.024 @ 0°	1.424	–	–
78. Diethylene glycol dipropionate	$(CH_3CH_2COOCH_2CH_2)_2O$	$C_{10}H_{18}O_5$	218	1.066[c]	1.429	127	–
79. Triethylene glycol diacetate	$(CH_2OCH_2CH_2OCOCH_3)_2$	$C_{10}H_{18}O_6$	234	1.115	1.437	–	–
80. Triethylene glycol dipropionate	$(CH_2OCH_2CH_2OCOC_2H_5)_2$	$C_{12}H_{22}O_6$	262	1.066	1.436	–	<0.01[c]
81. Triethylene glycol di-(2-ethylbutyrate)	$C_5H_{11}CO(OC_2H_4)_3OCOC_5H_{11}$	$C_{18}H_{34}O_6$	346	0.9946[c]	1.4404[c]	196	<0.01
82. Triethylene glycol di-caprylate-caprate	–	–	400 avg.	0.965	1.4455	185	–
83. Triethylene glycol di-(2-ethylhexoate)	$C_7H_{15}CO(OC_2H_4)_3OCOC_7H_{15}$	$C_{22}H_{42}O_6$	403	0.9679[c]	1.4441	207	–
84. Triethylene glycol dicaprylate	$(CH_2OCH_2CH_2OCOC_7H_{15})_2$	$C_{22}H_{42}O_6$	403	0.966	1.453	205	–
85. Tetraethylene glycol dicaprylate	$(C_7H_{15}COOCH_2CH_2OCH_2CH_2)_2O$	$C_{24}H_{46}O_7$	447	0.985	–	210	–

*Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a] CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS	MANUFACTURERS[b]
	°C.	°C.	% by wt.												
36.	275–320	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1221 (47)	47
37.	290–325	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1232 (47)	47
38.	322–365	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1242 (47)	47
39.	330–370	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1248 (47)	47
40.	365–390	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1254 (47)	47
41.	400–430	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1262 (47)	47
42.	385–420	–	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1260 (47)	47
43.	435–450	135–160	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 1268 (47)	47
44.	230–320 @ 4 mm.	60–66	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 4465 (47)	47
45.	215–300 @ 4 mm.	50–61	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 5442 (47)	47
46.	280–335 @ 4 mm.	100–105.5	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 5460 (47)	47
47.	–	66–72	Ins.	I	C	C	C	–	C	C	C	C	C	"Aroclor" 2565 (47)	47
48.	205–209	165–168(tech.) 174–178(USP)	0.170	C	C	C	–	–	–	–	–	–	–	—	25, 29
49.	211–222 @ 5 mm.	10.5	0.01	–	–	–	–	–	–	–	–	–	–	"RC" BD-8 (60)	60
50.	127 @ 1 mm.	−55	6.1[c]	C	C	C	C	–	P	C	C	C	C	"Citroflex" 2 (56)	48, 56
51.	170 @ 1 mm.	−85	<0.002	C	C	C	C	–	C	C	C	C	C	"Citroflex" 4 (56)	17, 22, 56
52.	132 @ 1 mm.	−50	0.72	C	C	C	C	–	C	C	C	C	C	"Citroflex" A2 (56)	56
53.	173 @ 1 mm.	−80	<0.002	P	P	C	C	–	C	C	C	C	C	"Citroflex" A4 (56)	56
54.	215 @ 1 mm.	−80	Ins.	–	–	–	–	–	–	C	C	C	C	"Citroflex" A6 (56)	56
55.	225 @ 1 mm.	–	Ins.	I	I	P	P	I	–	I	I	C	C	"Citroflex" A8 (56)	56
56.	Dec. at 160	−20	Ins.	–	C	C	C	C	–	–	P	C	C	DP-520 (24)	24, 36
57.	200–250	–	<0.01	P	C	C	C	P	C	C	P	C	C	KP-90 (54)	54
58.	–	0–5	Ins.	I	I	C	C	–	–	I	–	C	C	PX-800 (57)	57
59.	235 @ 2 mm.	–	Ins.	–	C	C	C	–	–	I	–	C	C	"Admex" 745 (5)	5
60.	180–210 @ 3 mm.	–	Ins.	–	C	C	C	–	–	I	–	C	C	"Admex" 744 (5)	5
61.	–	–	Ins.	–	P	C	C	I	I	–	–	C	C	"Admex" 711 (5)	5
62.	–	–	Ins.	–	P	C	C	I	I	I	I	C	C	"Admex" 710 (5), "Epoxidol" 780 (58)	5, 58
63.	260 @ 2 mm.	−22	Ins.	–	C	C	C	–	–	–	–	C	C	"Drapex" 4.4 (6)	6
64.	–	−1	Ins.	–	–	–	–	–	–	–	–	–	–	"Monoplex" S-70 (59)	59
65.	238 @ 5 mm.	−2	Ins.	I	I	C	C	–	–	I	I	C	C	"Monoplex" S-71 (59)	59
66.	240 @ 2 mm.	−13.5	Ins.	–	C	C	C	–	–	–	–	C	C	"Drapex" 3.2 (6)	6
67.	295–298	4–5	Ins.	–	–	–	–	–	–	–	–	–	–	"Plastoflex" DBE (1)	1
68.	175–190	–	<0.01	P	P	P	C	–	C	C	C	C	C	"KP"-555 (54)	54
69.	272 @ 50 mm.	−80	<0.01	I	C	C	C	I	–	I	C	C	C	"Flexol" 8N8 (14)	14
70.	–	125–127	Ins.	P	P	P	P	–	–	P	–	P	P	—	52
71.	160–178 @ 30 mm.	<−30	∞	C	–	C	–	–	–	–	–	–	I	Acetin	22, 45
72.	142–153 @ 11 mm.	<−30	∞	C	–	C	–	–	–	–	–	–	I	Diacetin, "Kesscoflex" DIA (45)	22, 45
73.	259–262	−78	6.69	C	C	C	C	C	–	C	–	–	I	Triacetin, "Kesscoflex" TRA (45)	22, 26, 45, 48
74.	177–182 @ 20 mm.	<−50	0.313	C	C	C	C	–	–	C	–	–	–	Tripropionin	22
75.	315	<−75	0.010	C	C	C	–	–	–	–	–	–	–	Tributyrin	22, 26
76.	211	<−80	0.160	C	C	C	C	–	–	–	–	–	–	Ethylene dipropionate	22
77.	240	<−80	0.050	C	C	C	C	–	–	–	–	–	–	Ethylene dibutyrate	22
78.	110–118 @ 4 mm.	–	3.60	C	C	C	C	–	–	–	–	–	–	—	22
79.	170–197 @ 20 mm.	<−60	>50	C	C	C	C	C	–	–	–	–	–	—	22
80.	138–142 @ 2 mm.	<−60	6.70	C	C	C	C	C	–	–	–	–	–	—	22
81.	256 @ 5 mm.	–	0.02	I	C	C	C	C	–	C	C	C	C	"Flexol" 3GH (14)	14
82.	180–247 @ 2.5 mm.	–	Ins.	–	–	C	C	–	–	–	C	C	C	"Eldoplast" 45 (31), "Morflex" 800 (49)	31, 49
83.	218 @ 5 mm.	–	<0.01	I	C	C	C	C	–	I	P	C	C	"Flexol" 3GO (14)	14
84.	227–278 @ 6 mm.	−5 to −15	<0.1	I	P	C	C	P	–	–	C	C	C	"Morflex" 801 (49), SC (24), TG-8 (60)	24, 36, 49, 60
85.	–	−43	Ins.	–	–	–	–	–	–	–	–	C	C	DP-200 (24)	24, 36

[a]Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b]See list on page 614 for key to numbers.
[c]Measurement made at 20 °C. [d]The trade marks for plasticizers are shown in quotation marks.
[e]Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25° C.	R. I. AT 25° C.	F. P.	V. P.
						°C.	mm. Hg
86. Polyethylene glycol 200 di-(2-ethylhexoate)	$C_7H_{15}CO(OC_2H_4)_nOCOC_7H_{15}$	–	–	0.9892[c]	1.4470[c]	202	–
87. Hexanetriol – 1, 2, 6	$HOCH_2CH(OH)(CH_2)_3CH_2OH$	$C_6H_{14}O_3$	134	1.1063[c]	1.4771	–	0.01
88. Polyethylene glycol 200	$HO(CH_2CH_2O)_nH$	–	200 avg.	1.125[c]	1.4590[c]	171	–
89. Polyethylene glycol 300	$HO(CH_2CH_2O)_nH$	–	300 avg.	1.125[c]	1.4641[c]	196	–
90. Polyethylene glycol 400	$HO(CH_2CH_2O)_nH$	–	400 avg.	1.125[c]	1.4662[c]	224	–
91. Polyethylene glycol 600	$HO(CH_2CH_2O)_nH$	–	600 avg.	1.125[c]	–	246	–
92. Polyethylene glycol 1000	$HO(CH_2CH_2O)_nH$	–	1000 avg.	–	–	277	–
93. Polyethylene glycol 1500	$HO(CH_2CH_2O)_nH$	–	1500 avg.	1.151[c]	–	221	–
94. Polyethylene glycol 1540	$HO(CH_2CH_2O)_nH$	–	1300-1600	1.15[c]	–	238	–
95. Polyethylene glycol 4000	$HO(CH_2CH_2O)_nH$	–	3000-3700	1.204[c]	–	279	–
96. Polyethylene glycol 6000	$HO(CH_2CH_2O)_nH$	–	6000-7500	–	–	249	–
97. Polyethylene glycol 20M	$HO(CH_2CH_2O)_nH$	–	15,000-20,000	–	–	–	–
98. Polypropylene glycol 400	$HO(C_3H_6O)_nH$	–	400 avg.	1.007	1.4449	199	1.2 @ 25°
99. Polypropylene glycol 750	$HO(C_3H_6O)_nH$	–	750 avg.	1.004	1.4470	257	1.4 @ 25°
100. Polypropylene glycol 1200	$HO(C_3H_6O)_nH$	–	1200 avg.	1.003	1.4479	238	1.4 @ 25°
101. Polyalkylene glycol derivative	–	–	–	0.995	1.4490	221	–
102. Methyl phthalyl ethyl glycolate	$CH_3OCOC_6H_4COOCH_2COOC_2H_5$	$C_{13}H_{14}O_6$	266	1.220	1.504	193	–
103. Ethyl phthalyl ethyl glycolate	$C_2H_5OCOC_6H_4COOCH_2COOC_2H_5$	$C_{14}H_{16}O_6$	280	1.180	1.498	190	–
104. Butyl phthalyl butyl glycolate	$C_4H_9OCOC_6H_4COOCH_2COOC_4H_9$	$C_{18}H_{24}O_5$	336	1.097	1.490	199	–
105. Polyoxypropylene glycol ethylene oxide	$HO(C_2H_4O)_a(C_3H_6O)_b(C_3H_4O)_cH$	40-50% C_3H_4O	2000	1.05-1.06	–	–	–
106. Polyoxypropylene glycol ethylene oxide	$HO(C_2H_4O)_a(C_3H_6O)_b(C_2H_4O)_cH$	20-30% C_2H_4O	2000	1.025-1.035	–	–	–
107. Polyoxypropylene glycol ethylene oxide	$HO(C_2H_4O)_a(C_3H_6O)_b(C_2H_4O)_cH$	40-50% C_3H_4O	3000	1.04-1.05	–	–	–
108. Polyoxypropylene glycol ethylene oxide	$HO(C_2H_4O)_a(C_3H_6O)_b(C_2H_4O)_cH$	80-90% C_2H_4O	8000	–	–	–	–
Hydrocarbon							
109. Hydrocarbon, synthesized	–	–	300	0.873	1.4893	–	–
110. Hydrocarbon type	–	–	–	ca. 0.96-0.97	ca. 1.54-1.55	–	–
111. Hydrocarbon type	–	–	–	1.004-1.005	1.567-1.568	174	–
112. Hydrogenated triphenyl	–	–	–	1.001-1.007	1.560-1.575	174	–
113. Hydrocarbon type	–	–	–	1.02-1.07	1.6	121	–
114. Hydrocarbon type	$[(CH_3)_2C_{10}H_5CH_2]_2[(CH_3)_2C_{10}H_5]$	$C_{51}H_{50}$	662	1.09	1.591	–	–
115. Hydrocarbon type	–	–	–	1.051 @ 15.5°	–	–	–
116. Polyaromatic hydrocarbon oil	–	–	–	0.944 @ 15.6°	1.5556	146	–
117. Polyaromatic hydrocarbon oil	–	–	–	0.948 @ 15.6°	1.5568	149	–
118. Aromatic hydrocarbon condensate	–	–	230-250	1.06-1.09	1.60-1.62	>140	0.051 @ 26°
119. Aromatic hydrocarbon	–	–	230	1.045[c]	1.61	160	–
120. Aromatic hydrocarbon	–	–	412	0.9786 @ 15.6°	–	221	–
121. Hydrocarbon type	–	–	267	0.8899[c]	1.49	135	–
122. Aromatic hydrocarbon	–	–	270 avg.	1.014 @ 15.5°	1.577-1.597[c]	182	–
123. Aromatic hydrocarbon	–	–	325 avg.	1.032 @ 15.5°	1.590-1.630[c]	212	–
124. Light pine tar	–	–	–	1.070 @ 15°	–	83	–
125. Medium pine tar	–	–	–	1.070-1.075 @ 15°	–	125	–
126. Heavy pine tar	–	–	–	1.075-1.080 @ 15°	–	129	–
Lauric acid derivatives							
127. Butyl laurate	$C_{11}H_{23}COOC_4H_9$	$C_{16}H_{32}O_2$	256	0.857[c]	–	–	–
128. 1,2-Propylene glycol monolaurate	$C_{11}H_{23}COOCH_2CHOHCH_3$	$C_{15}H_{30}O_3$	258	0.911	–	–	–
129. Ethylene glycol monoethyl ether laurate	$C_{11}H_{23}COO(CH_2)_2OC_2H_5$	$C_{16}H_{32}O_3$	272	0.89	–	–	–
130. Ethylene glycol monobutyl ether laurate	$C_{11}H_{23}COO(CH_2)_2OC_4H_9$	$C_{18}H_{36}O_3$	300	0.883	–	–	–

* Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS	MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA		
	°C.	°C.	% by wt.												
86.	250@5 mm.	−80	<0.01	I	C	C	C	C	–	C	I	C	C	"Flexol" 4GO (14)	14
87.	178@5 mm.	–	ca. 35	–	–	C	–	–	–	–	–	–	–	—	14
88.	–	Sets to a glass at −65	∞	–	–	C	–	–	–	–	–	–	–	"Carbowax" 200 (14), P-4 (9)	9, 14, 42
89.	–	−15 to 8	∞	–	–	C	–	–	–	–	–	–	–	"Carbowax" 300 (14), P-6 (9)	9, 14, 42
90.	–	4-8	∞	–	–	C	–	–	–	–	–	–	–	"Carbowax" 400 (14), P-9 (9)	9, 14, 29, 42
91.	–	20-25	∞	–	–	C	–	–	–	–	–	–	–	"Carbowax" 600 (14), P-13 (9)	9, 14, 42
92.	–	37-40	ca. 70	–	–	C	–	–	–	–	–	–	–	"Carbowax" 1000 (14)	14, 42
93.	–	38-41	73	–	–	C	–	–	–	–	–	–	–	"Carbowax" 1500 (14), P-34 (9)	9, 14
94.	–	43-46	70	–	–	C	–	–	–	–	–	–	–	"Carbowax" 1540 (14)	14
95.	–	53-56	62	–	–	C	–	–	–	–	–	–	–	"Carbowax" 4000 (14)	14
96.	–	60-63	ca. 50	–	–	C	–	–	–	–	–	–	–	"Carbowax" 6000 (14), P-90 (9)	9, 14
97.	–	ca. 60	∞	–	–	–	–	–	–	–	–	–	–	"Carbowax" 20M (14)	14
98.	–	–	∞	–	–	I	–	–	–	–	–	–	–	Polyglycol P 400 (23)	23
99.	–	–	16.7	–	–	I	–	–	–	–	–	–	–	Polyglycol P 750 (23)	23
100.	–	–	19.4	–	–	I	–	–	–	–	–	–	—	Polyglycol P 1200 (23)	23
101.	–	–	–	–	–	–	–	–	–	–	–	–	–	"Flexol" B-400 (14)	14
102.	189@5 mm.	–	0.053	C	C	C	C	C	C	C	C	C	C	"Santicizer" M-17 (47)	47
103.	190@5 mm.	–	0.018	C	C	C	C	C	C	C	C	C	C	"Santicizer" E-15 (47)	47
104.	219@5 mm.	–	0.001	C	C	C	C	C	C	C	C	C	C	"Santicizer" B-16 (47)	47
105.	–	12	Sol.	I	C	C	C	C	P	C	C	C	C	"Pluronic" L44 (71)	71
106.	–	−11	Sol.	I	C	C	C	C	P	C	C	C	C	"Pluronic" L62 (71)	71
107.	–	21	Sol.	I	C	C	C	C	I	C	I	C	C	"Pluronic" L64 (71)	71
108.	–	50	Sol.	C	I	C	I	C	I	I	I	I	I	"Pluronic" F68 (71)	71
109.	315-393	–	Ins.	–	–	–	–	–	–	C	–	P	P	"Conoco" H-300 (18)	18
110.	–	ca. 25	Ins.	–	–	–	C	–	–	–	–	C	–	AP-25 (55), HB-20 (47)	36, 47, 55
111.	340-396	–	Ins.	I	I	I	P	C	C	–	–	P	P	"Neville" R-29 (51), "Picco" 10 (36)	36, 51
112.	340-396	–	Ins.	I	C	C	C	–	C	C	C	C	C	HB-40 (47)	47
113.	300-370	–	Ins.	–	C	P	C	C	C	–	P	C	C	"Nevinol" (51)	51
114.	>220@2 mm.	85	Ins.	C	C	C	C	C	C	C	C	C	C	"Kenflex" (44)	44
115.	–	–	Ins.	–	–	–	–	–	–	–	–	C	C	"Panaflex" BN-5 (4)	4
116.	290-379	–	Ins.	–	P	P	C	P	C	–	–	C	C	"Panaflex" BN-1 (4)	4
117.	303-388	–	Ins.	–	P	P	C	P	C	–	–	C	C	"Panaflex" BN-2 (4)	4
118.	300-370	5	Ins.	C	C	C	C	C	C	C	C	C	C	"Nevillac" 10° (51)	51
119.	–	−18	Ins.	P	C	–	C	C	C	P	C	C	C	"Mobilsol" C (64)	64
120.	–	–	Ins.	–	–	–	–	–	–	–	–	C	C	"Mobilsol" K (64)	64
121.	–	−51	Ins.	I	I	–	P	I	I	I	P	P	P	"Mobilsol" L (64)	64
122.	135-240	–	Ins.	P	P	P	C	–	C	–	C	C	P	"Dutrex" 25 (62)	62
123.	163-275	–	Ins.	I	P	P	C	–	C	–	C	C	P	"Dutrex" 20V (62)	62
124.	–	–	–	–	–	–	–	–	–	–	–	–	–	cf. Army Spec. 3-26C, PT-400 (12)	12
125.	–	–	–	–	–	–	–	–	–	–	–	–	–	cf. Fed. Spec. JJJ-T-121, PT-600 (12)	12
126.	–	–	–	–	–	–	–	–	–	–	–	–	–	PT-800 (12)	12
127.	175-260@20 mm.	0	Ins.	–	C	C	C	–	C	–	C	C	–	"Kesscoflex" BL (45)	24, 30, 45, 49
128.	–	0-12	Ins.	–	–	C	C	–	C	–	C	C	–	"Nopco" (53)	24, 32, 45, 49, 53
129.	–	−7 to −11	Ins.	–	C	C	C	–	C	–	C	C	–	Ethoxyethyl laurate	49
130.	156-198@5 mm.	−3 to −12	Ins.	–	C	C	C	–	C	–	C	C	C	Butoxyethyl laurate, "Kesscoflex" BCL (45)	45, 49

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20°C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25°C.	R. I. AT 25°C.	F. P. °C.	V. P. mm. Hg
131. Glycerol monolaurate	$C_{11}H_{23}COOCH_2CHOHCH_2OH$	$C_{15}H_{30}O_4$	274	0.970	–	–	–
132. Diethylene glycol monolaurate	$C_{11}H_{23}COOC_2H_4OC_2H_4OH$	$C_{16}H_{32}O_4$	288	0.960	–	–	–
133. Polyethylene glycol 400 dilaurate	$C_{11}H_{23}CO(OC_2H_4)_xCOOC_{11}H_{23}$	–	756	0.97	–	–	–
Maleic acid derivative							
134. Di-*n*-butyl maleate	$C_4H_9OCOCH:CHCOOC_4H_9$	$C_{12}H_{20}O_4$	228	0.9944	–	–	–
Myristic acid derivatives							
135. Isopropyl myristate	$C_{13}H_{27}COOCH(CH_3)_2$	$C_{17}H_{34}O_2$	270	0.849	1.432	146	–
136. *n*-Butyl myristate	$C_{13}H_{27}COOC_4H_9$	$C_{18}H_{36}O_2$	284	0.861	1.4394	174	–
137. Ethylene glycol monomethyl ether myristate	$C_{13}H_{27}COOCH_2CH_2OCH_3$	$C_{17}H_{34}O_3$	286	0.895	1.4406	174	–
Naphthalene derivatives							
138. Mixed amylnaphthalenes	–	$C_{10}H_{8-n}(C_5H_{11})_n$	–	0.92-0.94	1.5452	149	<0.01
139. Dinonylnaphthalene	$C_{10}H_6(C_9H_{19})_2$	$C_{28}H_{44}$	381	0.946[e]	1.549[e]	174	0.004@25°
Nitrile derivative							
140. Fatty acid nitrile	–	–	263	0.847	1.462@30°	180	1.0@140°
Oleic acid derivatives							
141. Methyl oleate	$C_{17}H_{33}COOCH_3$	$C_{19}H_{36}O_2$	296	0.870	1.4505	–16	–
142. *n*-Propyl oleate	$C_{17}H_{33}COOC_3H_7$	$C_{21}H_{40}O_2$	324	0.861	1.4494	–23	–
143. Isopropyl oleate	$C_{17}H_{33}COOCH(CH_3)_2$	$C_{21}H_{40}O_2$	324	0.866	–	–	–
144. Butyl oleate	$C_{17}H_{33}COOC_4H_9$	$C_{22}H_{42}O_2$	339	0.865	1.451[e]	180	–
145. Amyl oleate	$C_{17}H_{33}COOC_5H_{11}$	$C_{23}H_{44}O_2$	353	0.876	1.4545	186	<0.01
146. Octyl fatty acid esters	–	–	395	0.864	1.4520	210	<0.06@150°
147. Ethylene glycol monomethyl ether oleate	$C_8H_{17}CH=CH(CH_2)_7COOC_2H_4OCH_3$	$C_{21}H_{40}O_3$	341	0.895-0.902 @20°	1.453-1.455	197	0.23@150°
148. 1,2-Propylene glycol monooleate	$C_{17}H_{33}COOCH_2CHOHCH_3$	$C_{21}H_{40}O_3$	341	0.91-0.92	–	–	–
149. Ethylene glycol monobutyl ether oleate	$C_{17}H_{33}COOCH_2CH_2OC_4H_9$	$C_{24}H_{46}O_3$	382	0.887	–	–	–
150. Tetrahydrofurfuryl oleate	$C_{17}H_{33}COOCH_2\cdot OC_4H_7$	$C_{23}H_{42}O_3$	367	0.921-0.923	1.4622	210	–
151. Glycerol monooleate	$C_{17}H_{33}COOCH_2CHOHCH_2OH$	$C_{21}H_{40}O_4$	357	0.945	–	–	–
152. Diethylene glycol monooleate	$C_{17}H_{33}COOC_2H_4OC_2H_4OH$	$C_{22}H_{42}O_4$	371	0.938	–	–	–
153. Diethylene glycol monoethyl ether oleate	$C_{17}H_{33}COO(CH_2CH_2O)_2C_2H_5$	$C_{24}H_{46}O_4$	399	0.957	–	–	–
Palmitic acid derivatives							
154. Isopropyl palmitate	$C_{15}H_{31}COOCH(CH_3)_2$	$C_{19}H_{38}O_2$	299	0.830-0.850	1.425-1.445	–	–
155. *n*-Butyl palmitate	$C_{15}H_{31}COOC_4H_9$	$C_{20}H_{40}O_2$	313	0.865	1.4429	185	–
156. Isooctyl palmitate	$C_{15}H_{31}COOC_8H_{17}$	$C_{24}H_{48}O_2$	369	0.863[e]	–	213	–
157. Tetrahydrofurfuryl palmitate	$C_{15}H_{31}COOCH_2\cdot OC_4H_7$	$C_{21}H_{40}O_3$	341	–	–	–	–
Paraffin derivatives							
158. Chlorinated paraffin	–	$C_{20}H_{37}Cl_5$	455	1.13-1.14	1.500	None	–
159. Chlorinated paraffin	–	$C_{23}H_{43}Cl_7$	594	1.162-1.175	–	None	–
160. Chlorinated paraffin	–	$C_{24}H_{43}Cl_7$	580	1.13-1.17	1.504	None	–
161. Chlorinated paraffin	–	$C_{20}H_{34}Cl_8$	556	1.18	1.518	None	–
162. Chlorinated paraffin	–	$C_{24}H_{29}Cl_{21}$	1060	1.16-1.17	1.535	None	–
Pelargonic acid derivatives							
163. Diethylene glycol dipelargonate	$(C_8H_{17}COOC_2H_4)_2O$	$C_{22}H_{42}O_5$	387	0.966[e]	1.445-1.446	210	–
164. Triethylene glycol dipelargonate	$(CH_2OCH_2)_2(CH_2OCOC_8H_{17})_2$	$C_{24}H_{46}O_6$	431	0.964[e]	–	216	–
Pentaerythritol derivative							
165. Pentaerythritol fatty acid ester	–	–	–	0.997	1.453	247	0.27@200°
Phosphoric acid derivatives							
166. Triethyl phosphate	$(C_2H_5O)_3PO$	$C_6H_{15}O_4P$	182	1.065-1.072[e]	1.4055[e]	116	10@73°
167. Tributyl phosphate	$(C_4H_9O)_3PO$	$C_{12}H_{27}O_4P$	266	0.973-0.983[e]	1.4226[e]	193	–
168. Tri-(2-ethylhexyl) phosphate	$[C_4H_9CH(C_2H_5)CH_2O]_3PO$	$C_{24}H_{51}O_4P$	435	0.9262[e]	1.4432[e]	207	<0.01
169. Tributoxyethyl phosphate	$(C_4H_9OC_2H_4O)_3PO$	$C_{18}H_{39}O_7P$	398	1.020	1.434	222	<0.10@150°
170. Triphenyl phosphate	$(C_6H_5O)_3PO$	$C_{18}H_{15}O_4P$	326	1.185	1.563	225	–

* Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS		MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA			
	°C.	°C.	% by wt.													
131.	–	26-28	Ins.	–	–	C	C	–	C	–	C	C	C	"Morpel" X-574 (49)		24,28,32,45,49,53
132.	–	9-11	Ins.	–	–	C	C	–	–	–	C	–	C	"Glaurin" (32) "Morpel" X-870 (49)	"Witco" DGL (70)	15,24,32,45, 49,53,70
133.	–	4-14	Ins.	–	–	C	–	–	–	–	–	C	C	"Morpel" X-928 (49)		32,45,49,53
134.	281	<–80	–	–	–	–	–	–	–	C	–	–	–	—		11,52
135.	–	–	–	–	C	C	C	–	–	–	–	–	–	—		8,45,52
136.	180	3	Ins.	I	C	C	C	–	C	–	–	–	I	—		45,52
137.	175-180	15	Ins.	I	C	C	C	–	C	–	C	C	–	—		52
138.	290-400	–	Ins.	–	C	–	–	–	–	–	–	–	–	"Morpel" X-929 (49), "Pentalene" 195 (61)		49,61
139.	200-270@20 mm.	–	Ins.	I	I	C	C	I	C	–	I	–	C	"Morpel" X-841 (49)		49
140.	330-360	–4	Ins.	–	C	–	–	–	–	C	C	C	C	"Arneel" SD (7), ODN (36)		7,36
141.	167-170@2 mm.	–	Ins.	I	P	C	C	P	C	P	P	P	P	"Emery" 2301 (27)		15,27,53,65
142.	181-189@2 mm.	–	Ins.	I	P	C	C	P	C	P	P	P	P	"Emery" 2302 (27)		27,35,45,52
143.	173-181@2 mm.	–	Ins.	I	P	C	C	–	C	–	–	P	P	"Morflex" IPO (49)		35,45,49
144.	190-230@6.5 mm.	<–10	Ins.	I	C	C	C	–	C	C	C	C	I	"Kessco flex" BO (45) "Morpel" X-930 (49)	"Witcizer" 100-101 (70)	8,15,17,30,35,36,45, 49,53,54,60,65,70
145.	200-240@20 mm.	<–40	Ins.	–	–	C	C	–	–	–	C	C	–	—		49,53
146.	210-239@4 mm.	–	Ins.	I	I	C	C	P	C	P	C	P	–	"Ohopex" R-9 (54)		45,54
147.	198-225@4 mm.	–40	Ins.	I	C	C	C	–	P	P	C	C	C	Methoxyethyl oleate Kapsol (54)	"Kessco flex" MCO (45)	45,54
148.	–	–19 to –22	Ins.	–	–	C	C	–	–	–	–	C	–	—		28,32,45,49,53
149.	192-221@2 mm.	<–45	Ins.	–	–	C	C	–	–	–	–	C	–	Butoxyethyl oleate		32,45,49
150.	240@5 mm.	–25	Ins.	P	C	C	C	C	C	C	–	C	C	"Plastolein" 9250 (27)		1,27,50
151.	–	18	Ins.	P	P	P	P	P	P	P	P	P	P	"Emery" 2221 (27) "Morpel" X-570 (49)	"Plastoflex" VS (15) "Witco" GMO (70)	15,24,27,28,32,35, 45,49,53,65,70
152.	–	<–10	Ins.	–	–	C	C	–	–	–	–	–	–	"Morpel" X-565 (49),	"Witco" DGO (70)	15,28,32,35, 45,49,53,70
153.	–	0 to –15	Ins.	–	–	C	C	–	–	–	–	–	–	—		29
154.	–	–	–	–	–	C	C	–	–	–	–	–	–	—		8,45
155.	215-265@20 mm.	0 to 9	Ins.	I	C	C	C	–	C	–	–	–	I	—		30,45,53
156.	218-235@5 mm.	6-9	Ins.	I	I	C	C	–	C	–	–	I	I	0-16 (60)		45,49,60
157.	195@1.5 mm.	–	Ins.	–	C	–	–	–	–	–	–	–	–	—		22
158.	–	–	Ins.	P	C	P	C	C	C	C	P	C	C	"Chlorowax" LV (21)		21
159.	–	–	Ins.	P	P	P	C	C	C	C	P	C	C	"Clorafin" 42 (38) CP-40 (39)	"Stan-Chlor-Oil" (36) W-40 (9)	9,36,38,39
160.	–	–	Ins.	P	C	P	C	C	C	C	P	C	C	Cereclor 2 (41), "Chlorowax" 40 (21)		13,21,41
161.	–	–	Ins.	P	C	P	C	C	C	C	P	C	C	"Chlorowax" 50 (21)		21
162.	–	–	Ins.	C	C	P	C	C	C	C	P	C	C	"Chlorowax" 70 (21)		21
163.	229@5 mm.	–40	Ins.	I	C	C	C	–	I	P	C	C	C	"Morpel" X-931 (49), "Plastolein" 9055 DGP (27)		27,49
164.	225-255@5 mm.	+1 to –4	0.1	I	P	C	C	P	–	–	C	C	C	"Plastolein" 9404 TGP (27), "RC" TG-9 (60)		27,49,60
165.	261@4 mm.	–	–	I	–	C	C	I	P	I	P	C	C	"Hercoflex" 600 (38)		38
166.	216	–56	∞	C	C	C	C	C	C	–	C	–	C	—		26
167.	177-178@27 mm.	<–80	0.60	C	C	C	C	C	C	C	C	P	C	—		17,54
168.	230@10 mm.	–80	<0.01	P	P	C	C	I	–	I	C	C	C	"Flexol" TOF (14)		14
169.	215-228@4 mm.	<–70	0.1	C	P	C	C	C	P	C	C	C	C	KP-140 (54)		54
170.	220@5 mm.	49.9	0.002@54°	C	C	C	C	C	C	C	I	C	C	"Celluflex" TPP (16)		2,16,22,23,47,48

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25° C.	R. I. AT 25° C.	F. P.	V. P.
						°C.	mm. Hg
171. Cresyl diphenyl phosphate	$(CH_3C_6H_4O)(C_6H_5O)_2PO$	$C_{19}H_{14}O_4P$	337	1.208	1.560	232	5.0 @ 220°
172. Tricresyl phosphate	$(CH_3C_6H_4O)_3PO$	$C_{21}H_{21}O_4P$	368	1.165-1.168[c] 1.145	1.553-1.556	230-235	<0.02 @ 150°
173. Tri-dimethylphenyl phosphate	$[(CH_3)_2C_6H_3O]_3PO$	$C_{24}H_{27}O_4P$	410	1.145	1.5535	233	<0.01 @ 20°
174. Alkyl phosphate ester	(Plas. for polyvinyl alcohol)	–	–	1.122[c]	1.448	63	–
175. Alkyl aryl phosphate	$(C_8H_{17}O)(C_6H_5O)_2PO$	$C_{20}H_{27}O_4P$	362	1.089-1.093	1.507-1.510	224	1 @ 153°
176. Diphenyl mono-*o*-xenyl phosphate	$(C_6H_5O)_2(C_6H_5C_6H_4O)PO$	$C_{24}H_{19}O_4P$	402	1.20 @ 60°	1.582-1.590 @ 60°	225	–
177. Tri-*p*-*tert*-butylphenyl phosphate	$[(CH_3)_3CC_6H_4O]_3PO$	$C_{30}H_{39}O_4P$	495	–	–	275	–
178. Diethyl ethylphosphonate	$C_2H_5P(O)(OC_2H_5)_2$	$C_6H_{15}O_3P$	166	1.025[c]	1.4148[c]	105	–
179. Dibutyl butylphosphonate	$C_4H_9P(O)(OC_4H_9)_2$	$C_{12}H_{27}O_3P$	250	0.948[c]	1.4310[c]	155	–
180. Bis(2-ethylhexyl) 2-ethylhexylphosphonate	$C_8H_{17}P(O)(OC_8H_{17})_2$	$C_{24}H_{51}O_3P$	419	0.908[c]	1.4481[c]	215	–
181. O, O, O-triethyl phosphorothioate	$(C_2H_5O)_3PS$	$C_6H_{15}O_3PS$	198	1.074	1.4458	107	–
182. O, O, O-tributyl phosphorothioate	$(C_4H_9O)_3PS$	$C_{12}H_{27}O_3PS$	282	0.987	1.4491	146	–
183. O, O, O-triisooctyl phosphorothioate	$(C_8H_{17}O)_3PS$	$C_{24}H_{51}O_3PS$	451	0.933	1.4580	210	–
184. Tris(2-chloroethyl) phosphite	$(CLCH_2CH_2O)_3P$	$C_6H_{12}O_3CL_3P$	270	1.353[c]	1.4858	191	–
Phthalic acid derivatives							
185. Dimethyl phthalate	$C_6H_4(COOCH_3)_2$	$C_{10}H_{10}O_4$	194	1.189-1.191 1.192-1.194[c]	1.5168[c]	146	<0.01[c]
186. Diethyl phthalate	$C_6H_4(COOC_2H_5)_2$	$C_{12}H_{14}O_4$	222	1.118-1.123[c]	1.5019[c]	152	–
187. Dipropyl phthalate	$C_6H_4(COOC_3H_7)_2$	$C_{14}H_{18}O_4$	250	1.071	1.494	–	<0.01[c]
188. Dibutyl phthalate	$C_6H_4(COOC_4H_9)_2$	$C_{16}H_{22}O_4$	278	1.042	1.4926[c]	170-175	1.1 @ 150°
189. Di-isobutyl phthalate	$C_6H_4[COOCH_2CH(CH_3)_2]_2$	$C_{16}H_{22}O_4$	278	1.040[c]	1.4900	174	–
190. Diamyl phthalate	$C_6H_4(COOC_5H_{11})_2$	$C_{18}H_{26}O_4$	306	1.022	1.488[c]	171	–
191. Dihexyl phthalate	$C_6H_4(COOC_6H_{13})_2$	$C_{20}H_{30}O_4$	334	0.990-0.994	–	–	–
192. Dimethylisobutylcarbinyl phthalate	$C_6H_4[COOCH(CH_3)CH_2CH(CH_3)_2]_2$	$C_{20}H_{30}O_4$	334	0.983	1.4764	–	–
193. Butyl octyl phthalate	$C_4H_9OCOC_6H_4COOC_8H_{17}$	$C_{20}H_{30}O_4$	334	1.005-1.011[c]	1.4837	188	–
194. Butyl isodecyl phthalate (Decyl butyl phthalate)	$C_4H_9OCOC_6H_4COOC_{10}H_{21}$	$C_{22}H_{34}O_4$	363	0.992-0.998	–	193	–
195. Amyl isodecyl phthalate (Decyl amyl phthalate)	$C_5H_{11}OCOC_6H_4COOC_{10}H_{21}$	$C_{23}H_{36}O_4$	377	0.98	1.482	–	–
196. Di-*n*-octyl phthalate	$C_6H_4(COOC_8H_{17})_2$	$C_{24}H_{38}O_4$	391	0.978[c]	1.482	219	<0.20 @ 150°
197. Di-isooctyl phthalate	$C_6H_4(COOC_8H_{17})_2$	$C_{24}H_{38}O_4$	391	0.981	1.484	210	1.0 @ 200°
198. Dicapryl phthalate	$C_6H_4(COOC_8H_{17})_2$	$C_{24}H_{38}O_4$	391	0.965-0.970	1.480[c]	201	–
199. Mixed alcohol phthalate	Blended alcohol (average 8-carbon) phthalate	$C_{24}H_{38}O_4$	391	0.9861[c]	1.4844	–	–
200. Di-(2-ethylhexyl) phthalate	$C_6H_4(COOC_8H_{17})_2$	$C_{24}H_{38}O_4$	391	0.982	1.4859[c] 1.483	218 210	<0.01

*Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS		MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA			
	°C.	°C.	% by wt.													
171.	390	−40	Ins.	P	C	C	C	–	I	I	C	C	C	"Celluflex" 112 (16) "Kolflex" (46)	"Santicizer" 140 (47)	16, 36, 46, 47, 48
172.	265-285 @ 10 mm.	<−35	Ins.	C	C	C	C	P	C	C	C	C	C	"Cabflex" TCP (12) "Celluflex" 179-C (16) "Kolflex" (46)	"Kronitex" (54) "Lindol" (16) "PX"-917 (57)	3, 12, 16, 22, 36, 46, 47, 48, 50, 54, 57
173.	225-295 @ 10 mm.	−35 (pour pt.)	0.002 @ 25°	P	C	C	C	P	P	C	C	–	C	Trixylenyl phosphate, "Celluflex" 179-A (16)		16, 36, 48
174.	–	–	Sol.	–	–	–	–	–	–	–	–	–	–	"V-C" 1-318-19 (69)		69
175.	230 @ 5 mm.	–	–	P	C	–	C	–	C	C	C	C	C	"Santicizer" 141 (47)		47
176.	250-285 @ 5 mm.	–	Ins.	P	C	C	C	C	C	C	C	C	C	Dow P-5 (23)		23
177.	320 @ 5 mm.	95	Ins.	I	C	C	C	–	C	–	–	C	C	Dow P-77 (23)		23
178.	82-83 @ 11 mm.	–	Sol.	–	–	–	–	–	–	–	–	–	–	—		69
179.	127-128 @ 2.5 mm.	–	Ins.	–	–	–	–	–	–	–	–	–	–	—		69
180.	160-161 @ 0.25 mm.	–	Ins.	–	–	–	–	–	–	–	–	–	–	—		69
181.	93.5-94 @ 10 mm.	–	Ins.	–	–	C	C	–	–	–	–	–	–	—		69
182.	142-145 @ 4.5 mm.	–	Ins.	–	–	C	C	–	–	–	–	–	–	—		69
183.	160-170 @ 0.2 mm.	–	Ins.	–	–	C	C	–	–	–	–	–	–	—		69
184.	119 @ 0.15 mm.	–	Ins.	–	–	–	–	–	–	–	–	C	C	—		69
185.	282	0 5.5	0.45 @ 25°	C	C	C	C	C	C	C	C	P	C	"Palatinol" M (9)		9, 11, 22, 26, 29, 35, 43, 47
186.	296	−40 −4	0.09 @ 25°	C	C	C	C	C	C	C	C	P	C	"Palatinol" A (9)		9, 11, 22, 26, 29, 43, 47, 48, 68
187.	129-132 @ 1 mm.	–	0.015	C	C	–	–	–	–	–	–	–	–	—		22
188.	339 227-235 @ 37 mm.	−35	Ins.	C	C	C	C	C	C	C	C	C	C	"Celluflex" DBP (16) "Darex" DBP (20) DBP 705 (58) "Harflex" 140 (35) "Kolflex" (46) "Morflex" 140 (49)	"Palatinol" C (9) "Polycizer" DBP (36) "PX"-104 (57) "Staflex" DBP (19) "Witcizer" 300 (70)	3, 9, 11, 16, 17, 19, 20, 22, 26, 29, 34, 35, 36, 37, 43, 46, 47, 48, 49, 50, 54, 57, 58, 60, 63, 68, 70
189.	327	−50	<0.01	–	C	C	C	–	C	C	C	C	–	—		26, 35, 48
190.	342	<−55	0.01	I	C	C	C	C	–	C	C	P	C	—		22, 37, 46, 68
191.	210 @ 5 mm.	–	Ins.	P	C	C	C	C	C	C	C	C	C	"Harflex" 160 (35), "Morflex" 160 (49)		35, 49
192.	190-195 @ 5 mm.	–	Ins.	P	C	C	C	C	C	C	C	C	C	"Plastoflex" 520 (1)		1
193.	340 @ 740 mm.	−50	<0.04	–	–	–	–	–	–	–	–	–	–	"Elastex" 48-P (11)		11, 26, 46, 60
194.	220 @ 5 mm.	−45	Ins.	–	–	–	–	–	C	–	–	C	C	BDP 710 (58) "Elastex" 40-P (11) "Kolflex" (46) "Morflex" 135 (49)	"PX"-114 (57) "Santicizer" 603 (47) "Staflex" BDP (19)	3, 11, 19, 37, 46, 47, 49, 50, 57, 58, 60
195.	–	–	–	–	–	–	–	–	–	–	–	C	C	"Staflex" CP (19)		19
196.	220-248 @ 4 mm.	−25	Ins.	I	C	C	C	C	C	I	C	C	C	"Harflex" 150 (35), "Morflex" X-926 (49)		3, 20, 34, 35, 37, 48, 49, 50, 63
197.	239 @ 5 mm.	−45	Ins.	I	P	C	C	C	P	C	P	C	C	"Cabflex" Di-OP (12) "Darex" DIOP (20) "D.I.O.P." (54) DIOP 735 (58) "Elastex" 10-P (11) "Harflex" 120 (35)	"Hercoflex" 200 (38) "Kolflex" (46) "Morflex" 100 (49) "PX"-108 (57) "Staflex" DIOP (19) "Witcizer" 313 (70)	3, 11, 12, 19, 20, 26, 34, 35, 37, 38, 46, 47, 48, 49, 50, 54, 57, 58, 60, 63, 68, 70
198.	227-234 @ 4.5 mm.	<−60	<0.03	P	C	C	C	P	C	P	C	C	C	DCP 715 (58) "Elastex" 80-P (11) "Harflex" 180 (35)	"Monoplex" DCP (59) "Morflex" 120 (49)	11, 35, 37, 49, 53, 58, 59
199.	220-230 @ 4 mm.	−50 to −55	Ins.	I	C	–	C	C	C	–	–	C	C	"Good-rite" GP-261 (33), "Polycizer" 162 (36)		33, 35, 36, 37
200.	290 @ 50 mm.	−55	<0.01	I	C	C	C	C	C	I	P	C	C	"Cabflex" DOP (12) "Celluflex" DOP (16) "Darex" DOP (20) DOP 745 (58) "Elastex" 28-P (11) "Flexol" DOP (14) "Kolflex" (46)	"Morflex" 110 (49) "Palatinol" AH (9) "PX"-138 (57) "Staflex" DOP (19) "Witcizer" 312 (70) Dioctyl phthalate, DOP	9, 11, 12, 14, 16, 19, 20, 26, 34, 35, 37, 46, 47, 48, 49, 50, 54, 57, 58, 60, 63, 70

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25°C.	R. I. AT 25°C.	F. P.	V. P.
						°C.	mm. Hg
201. Di-(2-ethylhexyl) hexahydrophthalate	$C_6H_{10}[COOCH_2CH(C_2H_5)C_4H_9]_2$	$C_{24}H_{44}O_4$	397	0.9586°	1.4619°	218	2.2@200°
202. Dinonyl phthalate	$C_6H_4(COOC_9H_{19})_2$	$C_{26}H_{42}O_4$	419	0.965-0.972	1.4812	–	–
203. *n*-Octyl-*n*-decyl phthalate	$C_8H_{17}OCOC_6H_4COOC_{10}H_{21}$	$C_{26}H_{42}O_4$	419	0.968	1.481	228	–
204. Octyl decyl phthalate (Isooctyl isodecyl phthalate) (Isooctyl decyl phthalate)	$C_8H_{17}OCOC_6H_4COOC_{10}H_{21}$	$C_{26}H_{42}O_4$	419	0.967-0.977	1.481-1.485	228-232	0.01@150°
205. Di-decyl phthalate (Di-isodecyl phthalate)	$C_6H_4(COOC_{10}H_{21})_2$	$C_{28}H_{46}O_4$	447	0.964-0.966	1.479-1.483	221-235	–
206. Blend (50/50) of di-octyl and di-octyl-decyl phthalates	–	–	400	0.974	1.483	218	–
207. Blend (50/50) of di-octyl and di-decyl phthalates	–	–	–	0.972	1.4835	–	–
208. Mixed alcohol phthalate	–	–	–	0.9712°	–	–	–
209. Mixed alcohol phthalate	–	–	–	0.9927°	1.4868	–	1-8@200°
210. Mixed alkyl phthalates	Blend of 2/3 DIDP and 1/3 BBP	–	–	1.004-1.014	–	–	–
211. Mixed alkyl phthalate	Blend of 1/2 DIDP and 1/2 BBP	–	–	1.029-1.039	–	–	–
212. Mixed alkyl phthalate	Blend of 1/3 DIDP and 2/3 BBP	–	–	1.005-1.065	–	–	–
213. Mixed alkyl phthalate	Blend of di-isooctyl and di-*n*-octyl-*n*-decyl phthalate	–	400	0.973	1.482	218	–
214. Alkyl phthalate	–	–	–	0.956	–	–	–
215. Fatty acid phthalate	–	–	–	0.952°	1.478	224	<0.06@150°
216. Monomeric phthalate	–	–	–	0.9840	1.4875	–	0.69@200°
217. Diallyl phthalate	$C_6H_4(COOCH_2CH=CH_2)_2$	$C_{14}H_{14}O_4$	246	1.120°	1.516°	166	2.4@150°
218. Dihydrabietyl phthalate	–	–	–	1.055°	1.513°	–	–
219. Butyl cyclohexyl phthalate	$C_6H_4(COOC_4H_9)(COOC_6H_{11})$	$C_{18}H_{24}O_4$	304	1.076	1.5071°	194	–
220. Butyl benzyl phthalate (BBP)	$C_6H_4(COOC_4H_9)(COOCH_2C_6H_5)$	$C_{19}H_{20}O_4$	312	1.111-1.119	1.5336-1.5376	199	0.1@140°
221. Dicyclohexyl phthalate	$C_6H_4(COOC_6H_{11})_2$	$C_{20}H_{26}O_4$	330	1.148°	–	207	<0.06@150°
222. Di(methylcyclohexyl) phthalate	$CH_3C_6H_{10}OCOC_6H_4COOC_6H_{10}CH_3$	$C_{22}H_{30}O_4$	358	1.075	1.516	199	0.76@200°C.
223. Diphenyl phthalate	$C_6H_4(COOC_6H_5)_2$	$C_{20}H_{14}O_4$	318	1.28	1.572@74°	224	–
224. Alkyl aryl phthalate	$R_1OCOC_6H_4COOR_2$	–	<500	1.052-1.056°	1.517°	236	–
225. Alkyl aryl phthalate	$R_1OCOC_6H_4COOR_2$	–	–	1.033°	1.5112°	243	–
226. Dimethoxyethyl phthalate	$C_6H_4(COOC_2H_4OCH_3)_2$	$C_{14}H_{18}O_6$	282	1.171°	1.500	193	<0.01@20° 0.25@150°
227. Diethoxyethyl phthalate	$C_6H_4(COOC_2H_4OC_2H_5)_2$	$C_{16}H_{22}O_6$	310	1.120°	1.491	186	<0.01@20° 0.20@150°
228. Dibutoxyethyl phthalate	$C_6H_4(COOC_2H_4OC_4H_9)_2$	$C_{20}H_{30}O_6$	366	1.063	1.483	208	<0.01@20° 0.06@150°
229. Bis-(diethylene glycol monoethyl ether) phthalate	$C_6H_4(COOCH_2CH_2OCH_2CH_2OC_2H_5)_2$	$C_{20}H_{30}O_8$	398	1.12-1.14	1.492	232	<0.10@150°
230. Glycerol phthalate	–	–	–	1.04	1.5029	207	–
231. High molecular weight phthalate	–	–	–	1.0394@30°	1.4980@30°	216	–
232. High molecular weight phthalate	–	–	–	1.0137@30°	1.4925@30°	207	–
233. High molecular weight phthalate	–	–	–	0.9711°	–	–	–
234. High molecular weight phthalate	–	–	630	1.05	1.448	–	–
Polyesters							
235. Polyester	–	–	4000	1.15	1.4719	–	–
236. Polyester	–	–	1500	1.107	1.4803	–	–
237. Polyester	–	–	–	1.055°	1.4685°	288	–
238. Polyester	–	–	–	0.9517	1.4521°	200	–
239. Polyester	–	–	850	1.075°	1.463-1.464	277	–
240. Polyester	–	–	850	1.031°	1.4589	260	–
241. Polyester	–	–	ca. 1000	0.995	–	–	–

* Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

B. P.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS		MANUFACTURERS[b]
			CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA			
°C.	°C.	% *by wt.*													
201. 232@10 mm.	−53	Ins.	I	I	C	C	I	C	C	C	C	C	"Flexol" CC-55 (14)		14
202. 413	–	Ins.	–	–	–	–	–	C	–	–	C	C	"Morflex" 190 (49) "Palatinol" DN (9)	"Staflex" DNP (19)	9, 19, 26, 49
203. 241@5 mm.	–	Ins.	I	C	C	C	C	C	I	C	C	C	"Dinopol" 235 (54) DNODP (47)	"Hercoflex" 150 (38)	38, 47, 54
204. 235-248@4 mm.	−40	Ins.	P	C	C	C	P	C	P	C	C	C	"Cabflex" ODP (12) "Darex" IOIDP (S) (20) "Dinopol" IDO (54) "Dinopol" 235 (54) "Elastex" 18-P (11) "Kolflex" (46)	"Morflex" 175 (49) ODP 740 (58) "Polycizer" 562 (36) "PX"-118 (57) "Staflex" DIODP (19)	11, 12, 19, 20, 26, 35, 36, 37, 46, 48, 49, 50, 54, 57, 58, 60
205. 249-256@4 mm.	−53	Ins.	P	C	C	C	P	C	P	C	C	C	"Cabflex" DDP (12) "Darex" DIDP (20) DDP 725 (58) "Elastex" 90-P (11) "Flexol" 10-10 (14) "Good-rite" GP-266 (33) "Hercoflex" 210 (38)	"Kolflex" (46) "Morflex" 130 (49) "Palatinol" Z (9) "Polycizer" 662 (36) "PX"-120 (57) "Staflex" DDP (19)	9, 11, 12, 14, 19, 20, 26, 33, 35, 36, 37, 38, 46, 47, 48, 49, 54, 57, 58, 60
206. 240@5 mm.	–	Ins.	I	C	C	C	C	C	I	C	C	C	"Dinopol" MOP (54) "PX" (57)	"Santicizer" 601 (47)	47, 54, 57
207. –	–	Ins.	–	–	–	–	–	–	–	–	C	C	"Darex" IOIDP (B) (20) "Good-rite" GP-265 (33)	"PX" (57) "Santicizer" 602 (47)	20, 33, 47, 57
208. 245@5 mm.	–	Ins.	I	C	C	C	P	C	I	P	C	C	"Flexol" 810 (14), "Staflex" LP (19)		14, 19
209. 224@5 mm.	–	Ins.	I	C	C	C	P	C	I	P	C	C	"Flexol" 426 (14)		14
210. –	–	Ins.	I	P	C	C	C	C	C	C	C	C	"Santicizer" 606 (47)		47
211. –	–	Ins.	I	P	C	C	C	C	C	C	C	C	"Santicizer" 611 (47)		47
212. –	–	Ins.	I	P	C	C	C	C	C	C	C	C	"Santicizer" 614 (47)		47
213. 240@5 mm.	–	Ins.	I	C	C	C	C	C	I	C	C	C	"Dinopol" MOP (54) "Hercoflex" 250 (38)	"Palatinol" AG (9)	9, 38, 54
214. 240@5 mm.	–	Ins.	I	C	C	C	C	C	I	C	C	C	"Pittsburgh PX"-313 (57)		57
215. 215-235@4 mm.	–	0.01@25°	C	–	C	C	P	C	C	C	C	C	"Ohopex" Q-10 (54)		54
216. 241@5 mm.	–	Ins.	I	C	C	C	P	C	I	C	C	C	"Flexol" 380 (14)		14
217. 156-175@4 mm.	−70	Ins.	C	C	C	C	–	C	C	C	C	C	—		54
218. –	65	Ins.	I	–	C	P	I	P	I	P	C	P	"Cellolyn" 21 (38)		38
219. 189-222@5 mm.	–	<0.005	I	C	C	C	–	C	C	C	C	C	"Elastex" 50-B (11)		11
220. 370@760 mm.	–	0.0003@30°	P	C	–	C	–	C	C	C	C	C	"Morflex" 145 (49) "Palatinol" BB (9)	"Santicizer" 160 (47)	9, 47, 49
221. 212-218@5 mm.	58-65	Ins.	P	C	C	P	C	P	C	P	P	P	DCHP 730 (58) "Elastex" DCHP (11)	KP-201 (54)	11, 40, 54, 58
222. 250@2 mm.	–	Ins.	I	C	C	C	P	C	C	C	C	C	"Sextol" phthalate (40)		40
223. 250-257@14 mm.	69	Ins.	I	C	C	C	–	C	C	I	C	C	—		47
224. 262-288@4 mm.	–	Ins.	–	C	C	C	C	C	–	–	C	C	"Cabflex" HS-10 (12)		12
225. 283-290@4 mm.	–	–	–	C	C	C	C	C	–	–	C	C	"Cabflex" HS-31 (12)		12
226. 190-210@4 mm.	–	0.85	C	C	C	C	–	P	C	C	C	C	"Kesscoflex" MCP (45) "Methox" (54)	"Palatinol" O (9)	9, 22, 26, 45, 54
227. 188-215@4 mm.	31	0.25@25°	C	C	C	C	–	P	C	C	C	C	—		22
228. 210-233@4 mm.	–	<0.03@25°	I	C	C	C	C	C	C	C	C	C	"Kesscoflex" BCP (45) "Kronisol" (54)	"Palatinol" K (9)	9, 22, 45, 54
229. 200-260@4 mm.	−35	0.8@25°	C	C	C	C	–	P	C	–	C	C	Di-"Carbitol" phthalate Diethoxyethoxyethyl phthalate		45, 54
230. –	−10	Ins.	–	C	C	C	–	–	P	C	C	C	"Esterflex" B-1 (65)		65
231. –	–	Ins.	–	–	–	–	–	–	–	–	–	–	"Staflex" KA (19)		19
232. –	–	Ins.	–	–	–	–	–	–	–	–	–	–	"Staflex" KB (19)		19
233. 245@5 mm.	–	Ins.	I	C	C	C	P	C	I	P	C	C	"Flexol" 812 (14)		14
234. –	–	0.12	–	C	C	–	–	–	P	C	C	C	"Staflex" KD (19)		19
235. –	–	Ins.	I	C	C	I	I	C	P	I	C	C	"Admex" 760 (5)		5
236. –	–	Ins.	I	C	C	I	–	–	P	–	C	C	"Admex" 761 (5)		5
237. –	−10	<0.01	I	I	C	I	I	–	I	I	C	C	"Flexol" R-2H (14)		14
238. –	–	Ins.	–	–	–	–	–	–	–	–	C	C	DP-100 (24)		24, 36
239. –	<−25	Ins.	C	C	C	C	C	C	C	P	C	C	"Plastolein" 9715 (27)		27
240. –	<−25	Ins.	C	P	C	C	C	C	P	P	C	C	"Plastolein" 9720 (27)		27
241. –	0-5	Ins.	P	P	C	C	–	–	P	–	C	C	"Paraplex" G-61 (59)		59

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

NAME*	STRUCTURAL FORMULA	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25° C.	R. I. AT 25° C.	F. P.	V. P.
						°C.	mm. Hg
242. Polyester	–	–	8000	1.06	1.4699	316	–
243. Polyester	–	–	6000	1.15	1.4710	292	–
244. Polyester	–	–	2200	1.08	1.4660	272	–
245. Polyester	–	–	–	–	–	279	–
246. Polyester	–	–	>800	0.9898	1.4719	310	<1@330°
247. Polyester	–	–	ca. 1000	0.999	1.471	316	–
248. Polyester	–	–	–	1.03	1.460	246	–
249. Polyester	–	–	–	1.22	–	246	–
250. Polyester	–	–	–	0.9213	–	225	–
251. Polyester	–	–	–	0.9200	1.4485	218	–
252. Polyester	–	–	–	0.9550	1.4830	230	–
253. Polyester	–	–	–	0.9565	–	218	–
254. Polyester	–	–	ca. 3000	1.090	–	–	–
255. Polyester	–	–	2500	1.10°	1.4684	290	–
256. Polymeric plasticizer	Derived from neopentyl glycol	–	1200-1300	1.060°	1.4656°	279	–
Ricinoleic acid derivatives							
257. Methyl ricinoleate	$C_{17}H_{32}(OH)COOCH_3$	$C_{19}H_{36}O_3$	312	0.925	1.4620	190	–
258. Methyl acetyl ricinoleate	$C_{17}H_{32}(OCOCH_3)COOCH_3$	$C_{21}H_{38}O_4$	355	0.938	1.4545	196	–
259. Methyl acetyl ricinoleate (modified)	–	–	–	0.958	1.4580	207	–
260. Butyl ricinoleate	$C_{17}H_{32}(OH)COOC_4H_9$	$C_{22}H_{42}O_3$	355	0.917	1.4620	207	–
261. Isobutyl ricinoleate	$C_{17}H_{32}(OH)COOCH_2CH(CH_3)_2$	$C_{22}H_{42}O_3$	354	0.913	1.4610	218	–
262. *n*-Butyl acetyl ricinoleate	$C_{17}H_{32}(OCOCH_3)COOC_4H_9$	$C_{24}H_{44}O_4$	397	0.928	1.4555	210	–
263. Butyl acetyl polyricinoleate	–	–	362	0.913	1.4595	202	–
264. Isobutyl acetyl ricinoleate	$C_{17}H_{32}(OCOCH_3)COOCH_2CH(CH_3)_2$	$C_{24}H_{44}O_4$	396	0.928	1.4540	216	–
265. Ethylene glycol ricinoleate	$C_{17}H_{32}(OH)COOCH_2CH_2OH$	$C_{20}H_{38}O_4$	342	0.969	1.4740	241	–
266. Propylene glycol ricinoleate	$C_{17}H_{32}(OH)COOCH_2CHOHCH_3$	$C_{21}H_{40}O_4$	357	0.960	1.4695	221	–
267. Methoxyethyl ricinoleate	$C_{17}H_{32}(OH)COOCH_2CH_2OCH_3$	$C_{21}H_{40}O_4$	357	0.951	1.4645	207	–
268. Ethoxyethyl ricinoleate	$C_{17}H_{32}(OH)COO(CH_2)_2OC_2H_5$	$C_{23}H_{42}O_4$	371	0.929	–	–	–
269. Methoxyethyl acetyl ricinoleate	$C_{17}H_{32}(OCOCH_3)COOCH_2CH_2OCH_3$	$C_{23}H_{42}O_5$	399	0.960	1.4570	215	<0.04@150°
270. Methoxyethyl acetyl ricinoleate (modified)	–	–	–	0.968	1.4630	238	–
271. Glycerol monoricinoleate	$C_{17}H_{32}(OH)COOCH_2CHOHCH_2OH$	$C_{21}H_{40}O_5$	372	0.981	1.4770	265	–
272. Diethylene glycol monoricinoleate	$C_{17}H_{32}(OH)COO(CH_2CH_2O)_2H$	$C_{22}H_{42}O_5$	387	0.972-0.980	–	–	–
273. Diethylene glycol monoethyl ether ricinoleate	$C_{17}H_{32}(OH)COO(CH_2CH_2O)_2C_2H_5$	$C_{24}H_{46}O_5$	415	0.96	–	–	–
274. Propylene glycol diricinoleate	$[C_{17}H_{32}(OH)COO]_2(CH_2CHCH_3)$	$C_{39}H_{72}O_6$	637	0.938	–	–	–
275. Diethylene glycol diricinoleate	$[C_{17}H_{32}(OH)COOCH_2CH_2]_2O$	$C_{40}H_{74}O_7$	667	0.953	–	–	–
276. Glyceryl triacetyl ricinoleate	$[C_{17}H_{32}(OCOCH_3)COO]_3C_3H_5$	$C_{63}H_{110}O_{12}$	1060	0.965	1.4685	290	–
Sebacic acid derivatives							
277. Dimethyl sebacate	$CH_3OCO(CH_2)_8COOCH_3$	$C_{12}H_{22}O_4$	230	0.990	–	–	–
278. Diethyl sebacate	$C_2H_5OCO(CH_2)_8COOC_2H_5$	$C_{14}H_{26}O_4$	258	1.048	1.419	–	–
279. Dibutyl sebacate	$C_4H_9OCO(CH_2)_8COOC_4H_9$	$C_{18}H_{34}O_4$	314	0.935-0.942°	1.4423°	180	–
280. Dihexyl sebacate	$C_6H_{13}OCO(CH_2)_8COOC_6H_{13}$	$C_{22}H_{42}O_4$	371	0.920°	–	–	–
281. Dioctyl sebacate	$C_8H_{17}OCO(CH_2)_8COOC_8H_{17}$	$C_{26}H_{50}O_4$	427	0.913	1.449	215	–
282. Di-isooctyl sebacate	$C_8H_{17}OCO(CH_2)_8COOC_8H_{17}$	$C_{26}H_{50}O_4$	427	0.9160°	–	246	–

* Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS		MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA			
	°C.	°C.	% by wt.													
242.	–	13-15	0.004	I	I	C	I	I	I	P	I	C	C	"Paraplex" G-25 (59)		59
243.	–	<–78	Ins.	I	C	C	I	I	I	C	I	C	I	"Paraplex" G-40 (59)		59
244.	–	10	Ins.	I	C	C	I	I	I	C	P	C	C	"Paraplex" G-50 (59)		59
245.	–	10	Ins.	I	C	C	I	I	I	P	I	C	C	ABG (9), "Paraplex" G-53 (59)		9, 59
246.	–	0	Ins.	I	P	C	C	–	–	P	I	C	C	"Paraplex" G-60 (59)		59
247.	–	2	Ins.	I	I	C	C	I	I	I	I	C	C	"Paraplex" G-62 (59)		59
248.	–	–10	Ins.	–	C	C	C	C	–	–	P	C	C	DP-250 (24)		24, 36
249.	197@4 mm.	–	–	C	C	C	I	–	–	C	I	P	P	"Hercoflex" 900 (38)		38
250.	–	0	Ins.	P	P	C	C	–	–	C	–	C	C	"Morflex" P-10B (49)		49
251.	–	–21	Ins.	P	P	C	P	–	–	C	–	C	C	"Morflex" P-20B (49)		49
252.	–	–51	Ins.	P	P	C	P	–	–	C	–	C	C	"Morflex" P-30B (49)		49
253.	–	–37	Ins.	P	P	C	P	–	–	C	–	C	C	"Morflex" P-40B (49)		49
254.	–	–	Ins.	–	–	–	–	–	–	C	–	C	C	"Morflex" P-50 (49)		49
255.	–	–10	Ins.	I	C	C	I	I	C	P	I	C	C	"RC" BGA (60)		60
256.	–	–	<0.1	C	C	P	P	–	–	C	–	C	C	"Eastman" NP-10 (26)		26
257.	170@1 mm.	–30 (pour pt.)	Ins.	P	C	C	C	P	–	C	C	I	I	"Flexricin" P-1 (10)		10, 53
258.	185@1 mm.	<–30	Ins.	P	C	C	C	P	P	C	C	C	C	"Flexricin" P-4 (10)		10
259.	–	–40	Ins.	I	C	C	C	–	–	C	C	C	C	"Flexricin" 61 (10)		10
260.	185@1 mm.	–30	Ins.	I	C	C	C	–	P	C	C	I	C	"Flexricin" P-3 (10), "Staflex" BR (19)		10, 19, 45, 53
261.	–	–23	Ins.	I	C	C	C	–	P	C	C	I	I	"Flexricin" 16 (10)		10
262.	195@1 mm.	–32 to –65	Ins.	I	C	C	C	P	P	C	C	C	C	"Flexricin" P-6 (10), "Staflex" BRA (19)		10, 19
263.	–	–48	Ins.	I	C	C	C	–	P	C	C	P	C	PG-16 (10)		10
264.	–	–30	Ins.	I	C	C	C	–	P	C	C	C	C	"Flexricin" 66 (10)		10
265.	–	–21	Ins.	–	–	C	C	–	–	–	C	I	–	"Flexricin" 15 (10)		10
266.	–	<–16	Ins.	–	–	C	C	–	–	–	–	–	–	"Flexricin" 9 (10)		10, 45
267.	185@1 mm.	–37	Ins.	I	C	C	C	–	P	C	C	C	C	"Flexricin" P-1C (10), "Staflex" IX (19)		10, 19, 32
268.	–	<–70	Ins.	–	–	C	C	–	–	–	C	–	–	—		32
269.	195@1 mm.	–60	Ins.	I	C	C	C	–	P	C	C	C	C	"Flexricin" P-4C (10) KP-120 (54)	"Staflex" IXA (19)	10, 19, 54
270.	–	–46	Ins.	I	C	C	C	–	–	C	C	C	C	"Flexricin" 62 (10)		10
271.	–	<–50	Ins.	–	–	C	C	–	–	–	C	–	–	"Flexricin" 13 (10)		10, 15, 32, 45, 53
272.	–	<–60	Ins.	–	–	C	C	–	–	–	–	–	–	—		32, 45, 53
273.	–	<–50	Ins.	–	–	C	C	–	–	–	–	–	–	—		53
274.	–	–49 to –51	Ins.	–	–	C	C	–	–	–	–	–	–	—		45
275.	–	–12 to –15	Ins.	–	–	C	C	–	–	–	–	–	–	—		45
276.	–	–35 (pour pt.)	Ins.	I	I	C	C	–	P	C	–	C	C	"Flexricin" P-8 (10)		10
277.	294	–	V.sl.sol.	C	C	C	C	C	C	C	C	C	C	—		35
278.	308	1.3	0.190	I	C	–	–	–	–	–	–	–	–	—		22, 35
279.	344-345 175-180@3 mm.	–11	<0.01	I	C	C	C	C	C	C	C	C	C	DBS 755 (58) "Harflex" 40 (35) "Monoplex" DBS (59) "Morflex" 240 (49)	"Polycizer" DBS (36) "PX"-404 (57) "Staflex" DBS (19)	19, 34, 35, 36, 37, 49, 50, 57, 58, 59
280.	184@2 mm.	–	Ins.	P	P	C	C	C	C	C	C	C	C	"Harflex" 60 (35)		35
281.	248@4 mm.	–55	Ins.	I	P	C	C	C	C	P	P	C	C	"Darex" DOS (20) DOS 765 (58) "Harflex" 50 (35) "Monoplex" DOS (59)	"Morflex" 210 (49) "Polycizer" DOS (36) "PX"-438 (57) "Staflex" DOS (19)	19, 20, 26, 34, 35, 36, 37, 49, 50, 57, 58, 59, 60
282.	–	–50	Ins.	P	P	–	C	C	C	–	–	C	C	DIOS 760 (58)) "Monoplex" DIOS (59)	"Morflex" 200 (49) "Staflex" DIOS (19)	19, 34, 35, 37, 49, 57, 58, 59, 60, 70

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

	NAME*	STRUCTURAL FORMULA*	EMPIRICAL FORMULA	MOLECULAR WEIGHT	SP. GR. AT 25° C.	R. I. AT 25° C.	F. P.	V. P.
							°C.	mm. Hg
283.	Dibutoxyethyl sebacate	$(CH_2)_8(COOC_2H_4OC_4H_9)_2$	$C_{32}H_{62}O_6$	403	0.964-0.970	1.4447	–	–
284.	Butyl benzyl sebacate	$(CH_2)_8(COOC_4H_9)(COOCH_2C_6H_5)$	$C_{21}H_{32}O_4$	348	1.023	–	–	–
285.	Capryl benzyl sebacate	$C_8H_{17}OCO(CH_2)_8COOCH_2C_6H_5$	$C_{25}H_{40}O_4$	405	0.9970°	–	–	–
286.	Dibenzyl sebacate	$(CH_2)_8(COOCH_2C_6H_5)_2$	$C_{24}H_{30}O_4$	382	1.05	1.521°	236	–
287.	Mixed sebacate adipate ester	–	–	411	0.93	1.445	–	–
	Stearic acid derivatives							
288.	*n*-Butyl stearate	$C_{17}H_{35}COOC_4H_9$	$C_{22}H_{44}O_2$	341	0.855-0.862	1.4418	188	–
289.	Octyl stearate	$C_{17}H_{35}COOC_8H_{17}$	$C_{26}H_{52}O_2$	397	0.851-0.857	–	–	–
290.	Cyclohexyl stearate	$C_{17}H_{35}COOC_6H_{11}$	$C_{24}H_{46}O_2$	367	0.880-0.883 @30°	–	–	–
291.	1, 2-Propylene glycol monostearate	$C_{17}H_{35}COOCH_2CHOHCH_3$	$C_{21}H_{42}O_3$	343	0.93	–	–	–
292.	Ethylene glycol monomethyl ether stearate	$C_{17}H_{35}COOCH_2CH_2OCH_3$	$C_{21}H_{42}O_3$	343	0.885	–	–	–
293.	Ethylene glycol monobutyl ether stearate	$C_{17}H_{35}COOC_2H_4OC_4H_9$	$C_{24}H_{48}O_3$	385	0.877-0.882°	1.446	216	<0.01 @20° 0.06 @150°
294.	Glycerol monostearate	$C_{17}H_{35}COOCH_2CHOHCH_2OH$	$C_{21}H_{42}O_4$	359	0.970	–	–	–
295.	Methyl acetoxystearate	$C_{17}H_{34}(OCOCH_3)COOCH_3$	$C_{21}H_{40}O_4$	356	0.926	1.4460	215	–
296.	Butyl acetoxystearate	$C_{17}H_{34}(OCOCH_3)COOC_4H_9$	$C_{24}H_{46}O_4$	398	0.922	1.4480	207	–
297.	Methoxyethyl acetoxystearate	$C_{17}H_{34}(OCOCH_3)COOCH_2CH_2OCH_3$	$C_{23}H_{44}O_5$	400	0.948	1.4500	221	–
298.	Diethylene glycol distearate	$(C_{17}H_{35}COOC_2H_4)_2O$	$C_{40}H_{78}O_5$	639	0.96	–	–	–
299.	Tetraethylene glycol monostearate	$C_{17}H_{35}COO(CH_2CH_2O)_4H$	$C_{26}H_{52}O_6$	461	0.971	–	–	–
300.	Tetraethylene glycol distearate	$(C_{17}H_{35}COOCH_2CH_2OCH_2CH_2)_2O$	$C_{44}H_{86}O_7$	727	–	–	–	–
301.	Methyl pentachlorostearate (stabilized)	$Cl_5C_{17}H_{30}COOCH_3$	$C_{19}H_{33}O_2Cl_5$	471	1.19	–	164	0.015 @120°
	Styrene derivatives							
302.	Styrene resin	–	–	ca. 260	1.01 @60°	1.5809 @60°	165	–
303.	Styrene resin	–	–	ca. 310	1.04 @60°	1.5728 @60°	180	–
304.	Styrene derivative	–	–	ca. 250	1.08	1.599	–	–
	Succinic acid derivatives							
305.	Diethyl succinate	$C_2H_5OCOCH_2CH_2COOC_2H_5$	$C_8H_{14}O_4$	174	1.048	1.419	–	–
306.	Dibutyl succinate	$C_4H_9OCOCH_2CH_2COOC_4H_9$	$C_{12}H_{22}O_4$	230	0.974	1.428	–	–
	Sucrose derivative							
307.	Sucrose octaacetate	$C_{12}H_{14}O_3(OCOCH_3)_8$	$C_{28}H_{38}O_{19}$	679	1.28°	–	307	–
	Sulfonic acid derivatives							
308.	*o*- and *p*-Toluenesulfonamide	$CH_3C_6H_4SO_2NH_2$	$C_7H_9O_2NS$	171	1.313	–	206	–
309.	N-Ethyl *p*-toluenesulfonamide	$CH_3C_6H_4SO_2NHC_2H_5$	$C_9H_{13}O_2NS$	199	1.171 @65°	1.522 @65°	188	–
310.	*o*- and *p*-Toluene ethylsulfonamide	$CH_3C_6H_4SO_2NHC_2H_5$	$C_9H_{13}O_2NS$	199	1.188	1.540	174	–
311.	N-Cyclohexyl *p*-toluenesulfonamide	$CH_3C_6H_4SO_2NHC_6H_{11}$	$C_{13}H_{19}O_2NS$	253	1.125	–	–	–
	Tall oil derivative							
312.	Methyl ester of tall oil	–	–	310	0.96°	1.495°	178	–
	Tartaric acid derivatives							
313.	Diethyl tartrate	$C_2H_5OCO(CHOH)_2COOC_2H_5$	$C_8H_{14}O_6$	206	1.19	1.445	–	–
314.	Dibutyl tartrate	$C_4H_9OCO(CHOH)_2COOC_4H_9$	$C_{12}H_{22}O_6$	262	1.093	1.447	170	–

*Code for column headings: Sp. Gr. = specific gravity; R. I. = refractive index; F. P. = flash point (Cleveland and Open Cup); V. P. = vapor pressure; B. R. = boiling range; M. P. = melting point; S. in water = solubility in water; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

	B. R.	M. P.	S. IN WATER	COMPATIBILITY WITH PLASTICS[a]										COMMON NAMES, TRADE DESIGNATIONS, AND TRADE MARKS[d] FOR PLASTICIZERS	MANUFACTURERS[b]
				CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA		
	°C.	°C.	% by wt.												
283.	255@10 mm.	−10	Ins.	–	–	–	–	–	–	–	–	C	C	"Harflex" 80 (35), "Staflex" DBES (19)	19, 35
284.	245-285@10 mm.	–	Ins.	–	C	C	–	C	–	C	C	C	C	"Morflex" 245 (49)	35, 49
285.	245-267@4 mm.	−1.7	Ins.	P	P	C	C	C	C	P	P	C	C	—	35
286.	265@4 mm.	28	0.001	P	P	C	C	C	C	C	C	P	P	"Harflex" 90 (35), "Morflex" 250 (49)	35, 49
287.	–	–	Ins.	–	–	–	–	–	–	–	–	C	C	"Staflex" LA (19)	19
288.	220-225@25 mm.	16	0.2@25°	I	C	C	C	–	C	–	–	–	I	"Kesscoflex" BS (45) "RC" B-17 (60) "Kolflex" 308 (46) "Staflex" BS (19) "Morflex" BS (49) "Witcizer" 200-201 (70)	8, 9, 17, 19, 24, 35, 45, 46, 49, 53, 54, 60, 65, 70
289.	–	1-6	Ins.	–	–	–	–	–	–	–	–	–	–	—	45
290.	–	28-29	Ins.	I	I	C	C	–	C	–	–	–	I	—	45
291.	182-210@1 mm.	37-39	Ins.	–	–	C	–	–	–	–	–	–	–	—	15, 28, 32, 45, 53
292.	220-275@20 mm.	20-24	Ins.	–	C	C	C	–	–	–	–	–	–	"Kesscoflex" MCS (45) Methoxyethyl stearate	45
293.	215-250@4 mm.	15-17	Ins.	I	P	C	C	I	C	P	C	P	P	Butoxyethyl stearate KP-23 (54) "Kesscoflex" BCS (45)	45, 54
294.	–	55-57	Ins.	–	–	–	–	–	–	–	–	–	–	"Morpel" X-710 (49)	15, 24, 28, 32, 35, 45, 49, 53, 65, 70
295.	–	−7	Ins.	P	C	C	C	–	P	C	C	C	C	"Paricin" 4 (10)	10
296.	–	−7	Ins.	P	C	C	C	–	P	C	C	C	C	"Paricin" 6 (10)	10
297.	–	−7	Ins.	P	C	C	C	–	P	C	C	C	C	"Paricin" 4C (10)	10
298.	–	48	Ins.	–	–	C	C	–	–	–	–	–	–	"Morpel" X-932 (49)	15, 45, 49, 53
299.	–	35-40	Ins.	–	–	C	C	–	–	–	–	–	–	—	45, 53
300.	–	32-33	Ins.	–	–	–	–	–	–	–	–	–	–	—	45
301.	–	−39	Ins.	C	C	C	C	C	C	C	I	C	C	"MPS"-500 (39)	39
302.	150-300@5 mm.	–	Ins.	I	C	P	C	P	C	P	C	P	P	Dow resin 276-V2 (23)	23
303.	150-300@5 mm.	–	Ins.	I	C	P	C	P	C	P	C	P	P	Dow resin 276-V9 (23)	23
304.	>300	−15	Ins.	C	C	C	C	C	C	C	C	C	C	"Nevillac" TS (51)	51
305.	218	−22	0.190	C	C	C	–	–	–	–	–	–	–	—	22, 52
306.	255	−19	0.023	C	C	C	–	–	–	–	–	–	–	—	22, 52
307.	260@0.01 mm.	89	0.09	C	–	C	C	–	–	C	–	–	–	SOA (14)	14
308.	360	105	ca. 1	P	P	P	C	–	I	C	I	I	I	"Santicizer" 9 (47)	47
309.	340	58	0.6@34°	C	C	–	–	–	–	–	–	–	–	"Santicizer" 3 (47)	47
310.	340	18	0.13@23°	C	C	C	C	–	C	C	C	I	I	"Santicizer" 8 (47)	47
311.	350	86	–	P	P	C	C	–	P	–	–	–	–	"Santicizer" 1-H (47)	47
312.	–	–	Ins.	P	–	P	C	–	–	P	C	C	C	"Metalyn" (38)	38
313.	280	17	>50	C	C	–	–	–	–	–	–	–	–	—	22, 43
314.	292-312	20-22	0.485	C	C	C	C	C	–	C	–	–	C	"Kesscoflex" DBT (45), "Witcizer" (70)	22, 45, 70

[a] Code for compatibility: C = compatible, P = partially compatible, I = incompatible. [b] See list on page 614 for key to numbers.
[c] Measurement made at 20 °C. [d] The trade marks for plasticizers are shown in quotation marks.
[e] Decomposes at temperatures in this range.

MANUFACTURERS OF PLASTICIZERS

1. Advance Solvents and Chemical Corp., Div. of Carlisle Chemical Works, Inc., 245 Fifth Ave., New York 16, N.Y.
2. American-British Chemical Supplies, Inc., 180 Madison Ave., New York 16, N.Y.
3. American Mineral Spirits Co., 155 E. 44th St., New York 17, N.Y.
4. Amoco Chemicals Corp., 910 S. Michigan Ave., Chicago 80, Ill.
5. Archer-Daniels-Midland Co., 700 Investors Bldg., Minneapolis 2, Minn.
6. Argus Chemical Corp., 633 Court St., Brooklyn 31, N.Y.
7. Armour and Co., 1355 W. 31st St., Chicago 9, Ill.
8. Arnold Hoffman and Co., Inc., 55 Canal St., Providence 1, R.I.
9. Badische Anilin- & Soda-Fabrik A.G., Ludwigshafen a. Rhein, Germany
10. Baker Castor Oil Co., 120 Broadway, New York 5, N.Y.
11. Barrett Div., Allied Chemical and Dye Corp., 40 Rector St., New York 6, N.Y.
12. Godfrey L. Cabot, Inc., 77 Franklin St., Boston 10, Mass.
13. Canadian Industries Ltd., Montreal, Canada
14. Carbide and Carbon Chemicals Co., Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N.Y.
15. Carlisle Chemical Works, Inc., Reading 15, Ohio
16. Celanese Corp. of America, Chemical Div., 180 Madison Ave., New York 16, N.Y.
17. Commercial Solvents Corp., 260 Madison Ave., New York 16, N.Y.
18. Continental Oil Co., Petrochemical Sales Dept., 630 Fifth Ave., New York 20, N.Y.
19. Deecy Products Co., 120 Potter St., Cambridge 42, Mass.
20. Dewey and Almy Chemical Co., Div. of W.R. Grace and Co., Cambridge 40, Mass.
21. Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio
22. Distillation Products Industries, Eastman Kodak Co., Rochester 4, N.Y. (small quantities only)
23. Dow Chemical Co., Midland, Mich.
24. E.F. Drew and Co., Inc., Boonton, N.J.
25. E.I. du Pont de Nemours and Co., Inc., Wilmington 98, Del.
26. Eastman Chemical Products, Inc., Kingsport, Tenn.
27. Emery Industries, Inc., 4300 Carew Tower, Cincinnati 2, Ohio
28. Emulsol Chemical Corp., 59 E. Madison St., Chicago 3, Ill.
29. Fisher Scientific Co., Greenwich and Morton Sts., New York 14, N.Y.
30. Food Machinery and Chemical Corp., Chemical Divisions, 161 E. 42nd St., New York 17, N.Y.
31. Foremost Food and Chemical Co., El Dorado Div., P.O. Box 599, Oakland 4, Calif.
32. Glyco Products Co., Inc., Empire State Bldg., New York 1, N.Y.
33. B.F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio
34. Griffin Chemical Co., Div. of Nopco Chemical Co., 1000 16th St., San Francisco 7, Calif.
35. Harchem Div., Wallace and Tiernan, Inc., 25 Main St., Belleville 9, N.J.
36. Harwick Standard Chemical Co., 60 S. Seiberling St., Akron 5, Ohio
37. Hatco Chemical Co., P.O. Box 309, King George Rd., Fords, N.J.
38. Hercules Powder Co., Wilmington 99, Del.
39. Hooker Electrochemical Co., 60 E. 42nd St., New York 17, N.Y.
40. Howards and Sons (Canada) Ltd., P.O. Box 995, Cornwall, Ontario, Canada
41. Imperial Chemical Industries Ltd., Millbank, London S.W. 1, England
42. Jefferson Chemical Co., Inc., 260 Madison Ave., New York 16, N.Y.
43. Kay-Fries Chemicals, Inc., 180 Madison Ave., New York 16, N.Y.
44. Kenrich Corp., 57-02 48th St., Maspeth 78, N.Y.
45. Kessler Chemical Co., Inc., State Rd. and Cottman Ave., Philadelphia 35, Pa.
46. Kolker Chemical Corp., 600 Doremus Ave., Newark 5, N.J.
47. Monsanto Chemical Co., Organic Chemicals Div., St. Louis 1, Mo.
48. Montrose Chemical Co., 104 Lister Ave., Newark 5, N.J.
49. Morton-Withers Chemical Co., 2110 High Point Road, Greensboro, N.C.
50. Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
51. Neville Chemical Co., Neville Island, Pittsburgh 25, Pa.
52. New York Quinine and Chemical Works, Inc., 50 Church St., New York 8, N.Y.
53. Nopco Chemical Co., First and Essex Sts., Harrison, New Jersey
54. Ohio-Apex Div., Food Machinery and Chemical Corp., Nitro, W. Va.
55. Pennsylvania Industrial Chemical Corp., Clairton, Pa.
56. Charles Pfizer and Co., Inc., 630 Flushing Ave., Brooklyn 6, N.Y.
57. Pittsburgh Coke and Chemical Co., Grant Bldg., Pittsburgh 19, Pa.
58. Reichhold Chemicals, Inc., 525 Broadway, White Plains, N.Y.
59. Rohm & Haas Co., Resinous Products Div., 222 W. Washington Sq., Philadelphia 5, Pa.
60. Rubber Corp. of America, New South Rd., Hicksville, L.I., N.Y.
61. Sharples Chemicals Div., Pennsylvania Salt Mfg. Co., 3 Penn Center Plaza, Philadelphia 2, Pa.
62. Shell Oil Co., 50 W. 50th St., New York 20, N.Y.
63. Sherwin-Williams Co., The, Pigment, Color and Chemical Div., 260 Madison Ave., New York 16, N.Y.
64. Socony Mobil Oil Co., Inc., 150 E. 42nd St., New York 17, N.Y.
65. Swift and Co., Industrial Oil Dept., 1800 165th St., Hammond, Ind.
66. Tennessee Products and Chemical Corp., Nashville 3, Tenn.
67. Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N.J.
68. U.S. Industrial Chemicals Co., Div. of National Distillers Products Corp., 99 Park Ave., New York 16, N.Y.
69. Virginia-Carolina Chemical Corp., 401 E. Main St., Richmond 5, Va.
70. Witco Chemical Co., 122 E. 42nd St., New York 17, N.Y.
71. Wyandotte Chemicals Corp., Wyandotte, Mich.

Bibliography of Books and Magazines

Abraham, H., "Asphalt and Allied Substances." 5th edition. 1945. New York: D. Van Nostrand Co., Inc.

Alfrey, T., Jr., "Mechanical Behavior of High Polymers." High Polymers Series, Vol. VI. 1948. New York: Interscience Publishers, Inc.

Alfrey, T., Jr., Bohrer, J. J., and Mark, H., "Copolymerization." 1952. New York: Interscience Publishers, Inc.

Amber-Hi-Lites. Published bimonthly. Philadelphia: Rohm and Haas Co.

Arnold, J. S., "Development of Nondestructive Tests for Structural Adhesive Bonds. Wright Air Development Center Technical Rep. 54-321, Part 4. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

"A.S.T.M. Book of Standards." 7 vols. 1955. Philadelphia: American Society for Testing Materials.

"A.S.T.M. Standards on Adhesives." 1954. Philadelphia: A.S.T.M.

"A.S.T.M. Standards on Plastics." 1957. Philadelphia: A.S.T.M.

A.S.T.M. Special Technical Publication 132, "Plastics Testing —Present and Future." 1953. Philadelphia: American Society for Testing Materials.

A.S.T.M. Special Technical Publication 138, "Testing Adhesives for Durability and Permanence." 1953. Philadelphia: American Society for Testing Materials.

A.S.T.M. Technical Publication No. 185, "Symposium on Speed of Testing of Nonmetallic Materials." 1957. Philadelphia: American Society for Testing Materials.

A.S.T.M. Special Technical Publication 194, "Tension Testing of Non-Metallic Materials." 1957. Philadelphia: American Society for Testing Materials.

Australian Plastics. Monthly magazine. Sydney: Australian Trade Publications Pty., Ltd.

"Australian Plastics Year Book." 1954-1955. Sydney: Australian Trade Publications Pty.

Bakelite Review. Published quarterly. New York: Bakelite Co., a Division of Union Carbide Corp.

Becher, P., "Principles of Emulsion Technology." 1955. New York: Reinhold Publishing Corp.

Beutel, A. C., et al., "Polyurethanes." Mimeographed. 1956. Cambridge, Mass.: Polyurethane Assoc.

Bick, A. F., "Plastics for Fun." 1954. Milwaukee: Bruce Publishing Co.

Billmeyer, F. W., Jr., "Textbook of Polymer Chemistry." 1957. New York: Interscience Publishers, Inc.

Bjorksten, J., Tovey, H., Harker, B., and Henning, J., "Polyesters and their Applications." 1956. New York: Reinhold Publishing Corp.

Blom, A. V., "Organic Coatings in Theory and Practice." 1950. New York: Elsevier Publishing Co., Inc.

Blout, E. R., Hohenstein, W. P., and Mark, H., "Monomers." 1951. New York: Interscience Publishers, Inc.

Boundy, R. H., and Boyer, R. F., "Styrene, Its Polymers, Copolymers, and Derivatives." 1952. New York: Reinhold Publishing Corp.

Bovey, F. A., Kolthoff, I. M., Medalia, A. I., and Meehan, E. J., "Emulsion Polymerization." 1955. New York: Interscience Publishers, Inc.

"Brauns, F. E., "The Chemistry of Lignin." 1952. New York: Academic Press, Inc.

British Plastics. Monthly magazine. London: Iliffe and Sons.

British Plastics Federation. Abstracts. Published monthly. London: British Plastics Federation.

"British Plastics Year Book." 1957. London: Iliffe and Sons.

Browning, E., "Toxicity of Industrial Organic Solvents." 1953. New York: Chemical Publishing Co., Inc.

Burnett, G. M., "Mechanism of Polymer Reactions." 1954. New York: Interscience Publishers.

Burns, R. M., and Bradley, W. W., "Protective Coatings for Metals." 1955. New York: Reinhold Publishing Corp.

Carswell, T. S., "Phenoplasts—their Structure, Properties, and Chemical Technology," High Polymers Series Vol. VII. 1947. New York: Interscience Publishers, Inc.

Celanese Plastics. Published monthly. New York: Celanese Corp. of America.

Cellulosic Plastics. Issued three times each year. Wilmington: Cellulose Products Dept., Hercules Powder Co.

Chemmunique. Published bimonthly. Wilmington: Atlas Powder Co.

Clark, F., Rutzler, J. E., Jr., and Savage, R. L., "Adhesion and Adhesives." 1954. New York: John Wiley and Sons, Inc.

Couzens, E. G., and Yarsley, V. E., "Plastics in the Service of Man." 1956. Harmondsworth, Middlesex: Penguin Books.

D'Alelio, G. F., "Fundamental Principles of Polymerization." 1952. New York: John Wiley and Sons, Inc.

Dearle, D. A., "Opportunities in Plastics." 1953. New York: Vocational Guidance Manuals, Inc.

Debing, L. M., editor, "Quality Control for Plastics Engineers." 1957. New York: Reinhold Publishing Corp.

DeBruyne, N. A., and Houwink, R., "Adhesion and Adhesives." 1951. New York: Elsevier Publishing Co., Inc.

DeBruyne, N. A., "Structural Adhesives." 1951. London: Lange, Maxwell, and Springer, Ltd.

Dietz, A. G. H., "Engineering Laminates." 1949. New York: John Wiley and Sons, Inc.

Delmonte, J., "Plastics Molding." 1952. New York: John Wiley and Sons, Inc.

Delorme, J., "Le Commerce des Matières Plastiques dans le Monde." 1956. Paris: Les Editions Amphora.

Delorme, J., "Anthologie des Brevets sur les Matières Plastiques." Part 1. "Résines Dérivées d'Hydrocarbures." 1956. Part 2.

"Dérivés des Alcools et Hydrates de Carbone." 1957. Paris: Les Editions Amphora.

Delorme, J., "Le Travail des Matières Plastiques en Feuilles, Plaques, Tubes, et Joncs." 1956. Paris: Les Editions Amphora.

Delorme, J., and Laroux P., "Les Conquêtes des Matières Plastiques en Médicine et en Chirurgie." 1955. Paris: Les Editions Amphora.

Doolittle, A. K., "Technology of Solvents and Plasticizers." 1954. New York: John Wiley and Sons, Inc.

Dow Diamond. Published bimonthly. Midland, Mich.: Dow Chemical Co.

Du Mond, T. C., "Shell Molding and Shell Mold Castings." 1954. New York: Reinhold Publishing Corp.

Du Pont Magazine. Published monthly. Wilmington: E. I. du Pont de Nemours & Co., Inc.

Du Pont Product Engineering Bulletin. Published bimonthly. Wilmington: E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept.

Durez Molder. Published monthly. North Tonawanda, N. Y.: Durez Plastics Div., Hooker Electrochemical Co.

Durez Plastics News. Published monthly. North Tonawanda, N. Y.: Durez Plastics Div., Hooker Electrochemical Co.

Durrans, T. H., "Solvents." 6th edition. 1950. New York: D. Van Nostrand Co., Inc.

Edwards, L., "Making Things of Plastics." 1954. Peoria: Charles A. Bennet Co., Inc.

Ellis, Carleton, "The Chemistry of Synthetic Resins." 1935. New York: Reinhold Publishing Corporation.

Epstein, G., "Adhesive Bonding of Metals." 1954. New York: Reinhold Publishing Corp.

Executive Newsletter. Issued six times or more a year. Springfield: Monsanto Chemical Co.

Fessenden, G. R., "Preservation of Agricultural Specimens in Plastics," U. S. Department of Agriculture Miscellaneous Publication No. 679. 1949. Washington, D. C.: Government Printing Office.

Flett, L. H., and Gardner, W. H., "Maleic Anhydride Derivatives, Reaction of the Double Bond." 1952. New York: John Wiley and Sons, Inc.

Flory, P. J., "Principles of Polymer Chemistry." 1953. Ithaca: Cornell University Press.

Formica World. Published monthly. Cincinnati: Formica Co.

Fournier, M., "L'Ère des Matières Plastiques." 1955. Paris: Dunod.

"France-Plastiques." 1956. Paris: Société des Éditions et Productions Publicitaires.

Frank, K., "Prüfungsbuch für Kautschuk und Kunststoffe." 1955. Stuttgart: Berliner Union.

Freund, M., "Plastics Molding Engineering." 1950. New York: Pitman Publishing Corp.

Fritz, J. C., "Flammenspritzen von Stahl, Metallen, und Kunststoffen." 1955. Essen: W. Girardet Verlag.

Gardner, H. A., and Sward, G. G., "Physical and Chemical Examination of Paints, Varnishes, Lacquers, and Colors." 1953. Bethesda: H. A. Gardner Laboratories.

Goodchemo News. Cleveland: B. F. Goodrich Chemical Co.

Gordon P. L., and Gordon, R., "Paint and Varnish Manual." 1955. New York: Interscience Publishers, Inc.

Grassie, N., "Chemistry of High Polymer Degradation Processes. 1956. New York: Interscience Publishers, Inc.

Greathouse, G. A., and Wessel, C. J., "Deterioration of Materials." 1954. New York: Reinhold Publishing Corp.

Gross, B., "Mathematical Structures of the Theories of Viscoelasticity." 1953. Paris: Hermann and Co.

Hagen, H., "Glasfaserverstaerkte Kunststoffe." 1957. Berlin: Springer Verlag.

Haim, G., and Neumann, J. A., "Manual for Plastic Welding, II. Polyethylene." 1954. Cleveland: Industrial Publishing Co.

Harris, M., "Handbook of Textile Fibers," 1954. Washington: Harris Research Laboratories, Inc.

Hercules Chemist. Published quarterly. Wilmington: Hercules Powder Co.

Hill, R., "Fibers from Synthetic Polymers." 1953. Houston: Elsevier Publishing Co., Inc.

Hooper, R., "Plastics for the Home Craftsman." 1953. Philadelphia: J. B. Lippincott Co.

Houwink, R. "Elastomers and Plastomers. I. Fundamentals of Synthetic Polymer Technology." 1950. New York: Elsevier Publishing Co., Inc.

Houwink, R., "Elastomers and Plastomers. II. Manufacture, Properties, and Applications." 1949. New York: Elsevier Publishing Co., Inc.

Houwink, R., "Elastomers and Plastomers. III. Testing and Analysis; Tabulation of Properties." 1949. New York: Elsevier Publishing Co., Inc.

"Indian Plastics Directory." 1954. Calcutta: Plastics and Machinery Distributors.

Industries des Plastiques Modernes. Monthly magazine. Paris: Société d'Études et de Recherches Techniques.

Interchemical Review. New York: Interchemical Corp.

Jacobs, M. B., and Scheflan, L., "Chemical Analysis of Industrial Solvents." 1953. New York: Interscience Publishers, Inc.

Journal of Polymer Science. Bimonthly magazine. New York: Interscience Publishers, Inc.

Jousset, J., "Matières Plastiques." 1955. Paris: Dunod.

Knight, R. A. G., "Adhesives for Wood." 1952. London: Chapman and Hall, Ltd.

Kraus, A., "Handbuch der Nitrocelluloselacke. Part I." 1956. Berlin-Wilmersdorf: Wilhelm Pansegrau Verlag.

Kunin, R., and Meyers, R. J., "Ion Exchange Resins." 1950. New York: John Wiley and Sons, Inc.

"Kunststoff Industrie der Schweiz." 1955. Zurich: Verlag fuer Wirschaftsliteratur, GmbH.

Kunststoff-Rundschau. Monthly magazine. Hamburg: Brunke Garrels, Verlagsbuchhandlung.

Lambert, F. H., "Molding of Plastics." 1950. London: Geo. Newnes, Ltd.

Learmonth, G. S., "Laminated Plastics." 1951. London: Leonard Hill, Ltd.

Lester Press. Published four times a year. Cleveland: Lester Engineering Co.

Luettzen, C. "Die Technologie der Klebstoffe." 1953. Berlin-Wilmersdorf: Wilhelm Pansegrau Verlag.

McGregor, R. B., "Silicones and

their Uses." 1954. New York: McGraw-Hill Book Co.

MacTaggart, E. F., and Chambers, H. H., "Plastics and Building." 1951. New York: Pitman Publishing Corp.

Mark H., and Tobolsky, A. V., "Physical Chemistry of High Polymeric Systems." 1950. New York: Interscience Publishers.

Marsden, C., "Solvent Manual." 1954. London: Cleaver-Hume Press, Ltd.

Martin, R. W., "The Chemistry of Phenolic Resins." 1956. New York: John Wiley and Sons, Inc.

Materie Plastiche. Bimonthly magazine. Milano: Editrice L'industria Soc. r. l.

"Matières Plastiques, Procédés de Transformation," 1956. Paris: Presses Documentaires.

Mellan, I., "Industrial Solvents." 1950. New York: Reinhold Publishing Corp.

Meyer, K. H., "Natural and Synthetic High Polymers." 1950. New York: Interscience Publishers, Inc.

Mienes, K., "Kunststoff Verarbeitung," 1955. Düsseldorf: Econ-Verlag, G.m.b.H.

Miles, F. D., "Cellulose Nitrate." 1955. New York: Interscience Publishers, Inc.

"Modern Packaging Encyclopedia." 1954. New York: Packaging Catalog Corp.

Modern Plastics. Monthly magazine. New York: Modern Plastics, Inc.

Monsanto Magazine. Published monthly. St. Louis: Monsanto Chemical Co.

Montcrieff, R. W., "Artificial Fibres." 1954. New York: John Wiley and Sons, Inc.

Morgan, P., "Glass Reinforced Plastics." 1954. New York: Philosophical Library, Inc.

Morgan, P., ed., "Plastics Progress 1955." 1956. New York: Philosophical Library.

Morrell, R. S., and Lanton, H. M., "Synthetic Resins and Allied Plastics." 1951. New York: Oxford University Press.

"Natural and Synthetic Fibres." Monthly abstracts. New York: Interscience Publishers, Inc.

Newall, R. G., "Metal-to-Metal Adhesives for the Assembly of Aircraft." 1955. San Francisco: Western Business Publications.

Oesterreichische Plastic-Rundschau. Magazine. Vienna: Ployer & Co.

Ohlinger, H., "Polystyrol. I." 1955. Berlin: Springer Verlag.

Ott, E., Spurlin, H. M., and Grafflin, M. W., "Cellulose and Cellulose Derivatives." 3 vols. 1954-55. New York: Interscience Publishers, Inc.

Payne, H. F., "Organic Coating Technology. I." 1954. New York: John Wiley and Sons, Inc.

Plaskon Magazine. Published quarterly. Toledo: Plaskon Div., Libbey-Owens-Ford Glass Co.

Plastica. Monthly magazine. Delft: Kunststoffeninstituut T.N.O.

"Plastic Pipe." 1955. Springfield, Mass.: Monsanto Chemical Co.

Plastics. Monthly magazine. London: Temple Press, Ltd.

"Plastics for Aircraft. I. Reinforced Plastics." ANC-17 Bulletin. 1955. Washington: Government Printing Office.

"Plastics in Building." 1955. Washington: Building Research Institute, National Research Council.

"Plastics in Housing." 1955. Prepared by M.I.T. Dept. of Architecture. Springfield, Mass.: Monsanto Chemical Co.

Plastics Industry News. Monthly magazine. Tokyo: Institute of Polymer Industry.

Plastics Merchandiser. Springfield: Monsanto Chemical Co.

Plastics Newsfront. Published monthly. New York: American Cyanamid Co., Plastics Div.

Plastics Packager. Springfield: Monsanto Chemical Co.

"Plastics Progress 1955." 1956. London: Iliffe and Sons, Ltd.

Plastics Progress. Published 8 times a year. Chicago: Chicago Molded Products Corp.

Plastics Sphere. Published quarterly. Montreal: Canadian Industries, Ltd.

Plastics Technology. Monthly magazine. New York: Bill Brothers Publishing Corp.

Plastics World. Monthly magazine. New York: Cleworth Publishing Co., Inc.

Plastverarbeiter. Published monthly. Edenkoben/Pfalz: Kurt Brandenburger.

Plesch, P. H., "Cationic Polymerization and Related Complexes." 1954. New York: Academic Press, Inc.

"Plexiglas Craftsman's Handbook." 1954. New York: Thomas Y. Crowell Co.

Poliplasti. Bimonthly magazine. Milano: E.T.A.S. Editrice.

"Polymer Degradation Mechanisms." National Bureau of Standards Circular 525. 1953. Washington: Government Printing Office.

Progress Thru Research. Quarterly. Minneapolis: General Mills, Inc.

R-B-H Dispersions. New York: R-B-H Division of Interchemical Corp.

Redfarn, C. A., "A Guide to Plastics." 1951. London: Iliffe and Sons, Ltd.

Resin Review. Philadelphia: Rohm & Haas Co.

"Resins — Rubber — Plastics." Monthly abstracts. New York: Interscience Publishers, Inc.

Revista de Plasticos. Bimonthly magazine. Madrid: Instituto "Alonso Barba."

Riddick, J. A., and Toops, E. E., Jr., "Organic Solvents." 1955. New York: Interscience Publishers, Inc.

Riddle, E. H., "Monomeric Acrylic Esters." 1954. New York: Reinhold Publishing Corp.

Riley, M. W., "Plastics Tooling." 1955. New York: Reinhold Publishing Corp.

Rochow, E. G., "An Introduction to the Chemistry of Silicones." 1951. New York: John Wiley and Sons, Inc.

Rohm & Haas Reporter. Published bimonthly. Philadelphia: Rohm & Haas Co.

Rubber and Plastics Age. Monthly magazine. London: Rubber and Technical Press, Ltd.

Saechtling, H., and Zebrowsky, W. "Kunststoff Taschenbuch." 12th edition. 1955. München: Karl Hansen Verlag.

Samuelson, O., "Ion Exchangers in Analytical Chemistry." 1953. New York: John Wiley and Sons, Inc.

Scheflan, L., and Jacobs, M., "The Handbook of Solvents." 1953. New York: D. Van Nostrand Co.

Schildknecht, E. E., "Polymer Processes." 1956. New York: Interscience Publishers, Inc.

Schildknecht, C. E., "Vinyl and Related Polymers." 1952. New York: John Wiley and Sons, Inc.

Seaman, R. G., and Merrill, A. M., "Machinery and Equipment for Rubber and Plastics. Vol. I. Primary Machinery and Equipment." 1952. New York: Bill Brothers Publishing Corp.

Seymour, R. B., and Steiner, R. H., "Plastics for Corrosion-Resistant Applications." 1955. New York: Reinhold Publishing Corp.

Simonds, H. R., Weith, A. J., and Schack, W., "Extrusion of Plastics, Rubber, and Metals." 1952. New York: Reinhold Publishing Corp.

"Simposio Internazionale di Chimica Macromolecolare," International Symposium on Macromolecular Chemistry of the International Union of Pure and Applied Chemistry, held in Milan and Turin from Sept. 26 to Oct. 2, 1954. 1955. New York: Interscience Publishers, Inc.

Sobotka, H., "Ion Exchange Resins in Medicine and Biological Research." 1953. New York: The New York Academy of Sciences.

Sonneborn, R. H., "Fiberglas Reinforced Plastics." 1954. New York: Reinhold Publishing Corporation.

Späth, W., "Beitraege zur Technologie der Hochpolymeren." 1956. Stuttgart: A. W. Gentner.

"SPE Journal." Monthly magazine. Athens, Ohio: Society of Plastics Engineers, Inc.

SPE, "Papers Presented at 12th Annual National Technical Conference." 1956. Athens, Ohio: Society of Plastics Engineers, Inc.

Society of the Plastics Industry, "Plastics Engineering Handbook." 1954. New York: Reinhold Publishing Corp.

Stannett, V., "Cellulose Acetate Plastics." 1950. London: Temple Press, Ltd.

"Structural Adhesives: Theory and Practice of Gluing with Synthetic Resins." 1952. London: Lange, Maxwell, and Springer, Ltd.

Stuart, H. A., editor. "Die Physik der Hochpolymeren; Part 1: Die Struktur des freien Molekuels; Part 2: Das Makromolekuel in Loesungen; Part 3: Ordnungszustaende und Umwandlungserscheinungen in festen, hochpolymeren Stoffen; Part 4: Theorie und molekulare Deutung technologischer Eigenschaften von hochpolymeren Werkstoffen." 1955-1956. Berlin: Springer Verlag.

Sutermeister, E., and Browne, F. L., "Casein and Its Industrial Applications." 1939. New York: Reinhold Publishing Corp.

"Technical Data on Plastics." 1957. Washington, D. C.: Manufacturing Chemists Assn., Inc.

Tobolsky, A. V., and Mesrobian, R. B., "Organic Peroxides." 1954. New York: Interscience Publishers, Inc.

Transaction of the Institute of the Plastics Industry. Semi-annual publication. London: Institute of the Plastics Industry.

Travers, R., "How to Make Professional Molds and Castings." 1951. Boston: Plastic Service Guild.

Von Fischer, W., and Bobalek, E. G., "Organic Protective Coatings." 1953. New York: Reinhold Publishing Corp.

Wakeman, R. L., "The Chemistry of Commercial Plastics." 1947. New York: Reinhold Publishing.

Walker, J. F., "Formaldehyde." 1953. New York: Reinhold Publishing Corp.

Ward, A. L., and William, J. R., "Styrene." 1951. New York: Interscience Publishers, Inc.

Warth, A. H., "The Chemistry and Technology of Waxes," 1947. New York: Reinhold Publishing.

Zimmerman, O. T., and Lavine, I., "Handbook of Material Trade Names." 1953. Supplement I. 1956. Dover, New Hampshire: Industrial Research Service.

Addresses of publishers

(Addresses of manufacturers of plastics whose industrial publications are listed in this bibliography will be found in the Directory Section.)

American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.
Australian Trade Publications Pty., Ltd., 171 Sussex Street, Sydney N.S.W., Australia.
Charles A. Bennet Co., Inc., 237 N. Monroe St., Peoria 3, Ill.
Berliner Union G.m.b.H., Stuttgart, Germany.
Bill Brothers Publishing Corp., 386 Fourth Ave., New York 16, N. Y.
Kurt Brandenburger, Klosterstr. 182, Edenkoben/Pfalz, Germany.
British Plastics Federation, 47-48 Piccadilly, London W. 1, England.
Bruce Publishing Co., 540 N. Milwaukee St., Milwaukee 1, Wis.
Building Research Institute, National Research Council, Washington 25, D. C.
Chapman and Hall, Ltd., 37-39 Essex St., London W.C. 2, England.
Chemical Publishing Co., Inc., 212 Fifth Ave., New York 10, N. Y.
Cleaver-Hume Press, Ltd., S. Audley St., London W. 1, England.
Cleworth Publishing Co., Inc., 551 Fifth Ave., New York 17, N. Y.
Cornell University Press, 124 Roberts Place, Ithaca, N. Y.
Thomas Y. Crowell Co., 432 Fourth Ave., New York 16, N. Y.
Dunod, 92 rue Bonaparte, Paris VI, France.
Econ-Verlag, G.m.b.H., Duesseldorf, Germany.
Les Editions Amphora, 119 Ave. Parmentier, Paris XI, France.
Editrice L'industria Soc. r.l., Via Farneti 8, Milano, Italy.
Elsevier Publishing Co., Inc., 402 Lovett Blvd., Houston 6, Texas.
E.T.A.S. Editrice, Via Mantegna 6, Milano, Italy.
H. A. Gardner Laboratories, 4723 Elm St., Bethesda 14, Md.
Brunke Garrels, Verlagsbuchhandlung, Borgfelder Strasse 83, Hamburg 26, Germany.
A. W. Gentner Verlag, Forststrasse 131, Stuttgart W., Germany.
W. Girardet Verlag, Essen, Germany.
Government Printing Office, Washington 25, D. C.
Karl Hanser Verlag, Leonard Eck Str. 7, Munich 27, Germany.
Harris Research Laboratories, 1246 Taylor St., N.W., Washington 11, D. C.
Hermann and Co., 6 Rue de la Sorbonne, Paris, France.
Leonard Hill, Ltd., 17 Stratford Place, London, W. 1, England.
Iliffe and Sons, Ltd., Dorset House, Stamford St., London S.E. 1, England.
Industrial Publishing Co., 1240 Ontario St., Cleveland 13, Ohio.
Industrial Research Service, Inc., Dover, N. H.
Institute of Polymer Industry, No. 5, 3-chome, Kanda, Surugadai, Chiyoda-ku, Tovko, Japan.
Institute of the Plastics Industry, Windsor House, Victoria St., London S.W. 1, England.
Instituto "Alonso Barba," Serrano 119, Madrid, Spain.
Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.
Kunststoffeninstituut T.N.O., Julianalaan 134, Delft, The Netherlands.
Lange, Maxwell, and Springer, Ltd., 41-45 Neal St., London W.C. 2, England.
J. B. Lippincott, Co., E. Washington Square, Philadelphia 5, Pa.
McGraw-Hill Co., Inc., 330 West 42nd St., New York 36, N. Y.
Manufacturing Chemists Assoc., Inc., 246 Woodward Bldg., Washington 5, D. C.
Modern Plastics, Inc., 575 Madison Ave., New York 22, N. Y.
George Newnes, Ltd., Tower House, 8-14 Southampton St., Strand, London W.C. 2, England.
New York Academy of Sciences, 2 East 63rd St., New York 21, N. Y.
Oxford University Press, 114 Fifth Ave., New York 11, N. Y.
Packaging Catalog Corp., 575 Madison Ave., New York 22, N. Y.
Wilhelm Pansegrau Verlag, Wilhelmsaue 22, Berlin-Wilmersdorf, Germany.
Penguin Books, Harmondsworth, Middlesex, England.
Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y.
Pitman Publishing Corp., 2 West 45th St., New York 19, N. Y.
Plastic Service Guild, 233 Condor St., E. Boston 28, Mass.
Plastics and Machinery Distributors, 4 Upper Chitpur Road, Post Bag 6703, Calcutta 7, India.
Ployer und Co., Aegidiengasse 5, Vienna VI, Austria.
Polyurethane Associates, P. O. Box 98, Cambridge 38, Mass.
Presses Documentaires, 28 rue Saint Dominique, Paris 7e France.
Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.
Rubber and Technical Press Ltd., Gaywood House, Great Peter Street, London, S. W. 1, England.
Société de Editions et Productions Publicitaires, 27 rue Laffite, Paris IX, France.
Société d'Etudes et de Recherches Techaiques, 18-20 Place de la Madeleine, Paris VIII, France.
Society of Plastics Engineers, 34 E. Putnam Ave., Greenwich, Conn.
Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y.
Springer Verlag, Reichpietschufer 20, Berlin W. 25, Germany.
Temple Press, Ltd., Bowling Green Lane, London E.C. 1, England.
D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y.
Verlag fuer Wirtschaftsliteratur G.m.b.H., Zurich, Switzerland.
Vocational Guidance Manuals, Inc., 45 West 45th St., New York 36, N. Y.
Western Business Publications, 274 Brannan St., San Francisco 7, Calif.
John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

Advertisers' Index

ENGINEERING AND METHODS

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 650.

CHROMIUM PLATING
Chromium Corporation of America 805
Micron Specialties Company, Inc. .. 644
Nutmeg Chrome Corporation 794

COLD MOLDING
American Insulator Corporation ... 648
Plastic Molding Corporation 794

COMPRESSION MOLDERS
American Insulator Corporation .. 648
Auburn Plastics, Inc. 808
Boonton Molding Co. 634
Butterfield, T. F., Inc. 810
Consolidated Molded Products Corp. 807
Davies, Harry, Molding Company .. 639
Diemolding Corporation 768
General American Transportation Corporation, Plastics Div. .. 771-774
General Die Mold Co. 776
General Industries Co., The .. 622, 623
Insulation Mfg. Company, Inc. 816
Industrial Molded Products Co., Inc. 767
Kuhn & Jacob Molding & Tool Co. . 649
Kurz-Kasch, Inc. 633
Mack Molding Company, Inc. 640
Midwest Molding and Manufacturing Company 792
Molded Products, Div. Admiral Corporation 777
Norton Laboratories, Inc. 801
Northwest Plastics, Inc. 629
Owens-Illinois 624
Penn-Plastics Corporation 814
Perry Plastics, Inc. 806
Plastic Molding Corporation 794
Plasticrafters, Inc. 761
Plastic Research Products Company, Div. Grimes Mfg. Co. 799
Recto Molded Products, Inc. 762
Resinoid Engineering Corporation. 812B
Richardson Company, The 638
Shaw Insulator Company 802
Sierra Electric Corp. 804
Trans-Matic Plastics Company 810
Waterbury Companies, Inc. 641
Watertown Mfg. Co., The 637
Zollinger, Albert, Inc. 756

CUSTOM FOAMERS
Schwab Plastics Corporation 794

DESIGN CONSULTANTS
H. M. S. Associates 814

DIE CASTING
Zapf, Charles, & Co. 756

DIE CUTTING
Emeloid 793

DIES
Johnson Manufacturing Company .. 811
Western Supplies Co. 815
Peterson, A. W., & Son Die Company, Inc. 812B

EXTRUDERS
Anchor Plastics Co., Inc. 805
Auburn Plastics, Inc. 808
Carlon Products Corporation 757
Commercial Plastics Co. 815
Contour Extrusion Company 781
Crescent Plastics, Inc. 755
Danielson Mfg. Co., Div. Nicholson File Co. 783
Detroit Macoid Corporation 816
General American Transportation Corporation, Plastics Div. .. 771-774
H & R Industries 769
Kingman, E. B., Co., Inc. 788
Lincoln Molded Plastics, Inc. 637
Mack Molding Company, Inc. 640
National Plastic Products Co., The . 792
Plastex Company, The 635
Plas-Tube Corporation 813
Rotuba Extruders Inc., The, Div. Waljohn Plastics Inc. 806
Sandee Manufacturing Company . 812A
Schwab Plastics Corporation 794
Sheffield Plastics Inc. 648
Sunlite Plastics, Inc. 788
Superior Plastics, Inc. 800
Tupper Corporation 778, 779
United States Gasket, Plastics Div. Garlock Packing Co. 790
Vacuum Plastics Corporation 804
Vogt Manufacturing Corp. 764
Waljohn Plastics, Inc. 812A
Yardley Plastics Co. 814

EXTRUSION SCREWS
Johnson Manufacturing Company .. 811

GEARS
Process Gear Co., Inc. 813

INJECTION MOLDERS
American Insulator Corporation ... 648
Amos Molded Plastics 787
Artag Plastics Corporation 625
Auburn Plastics, Inc. 808
Blackhawk Molding Co., Inc. 808
Boonton Molding Co. 634
Butterfield, T. F., Inc. 810
Byrd Plastics, Inc. 759
Chili Plastics, Inc. 776
Commercial Plastics Co. 815
Como Plastics, Inc. 813
Connecticut Plastic Products Co. ... 646
Consolidated Molded Products Corp. 807
Danielson Mfg. Co., Div. Nicholson File Co. 783
Detroit Macoid Corporation 816
Dillon-Beck Manufacturing Co. 644
Emeloid 793
Erie Resistor Corporation, Plastics Division 809
General American Transportation Corporation, Plastics Div. .. 771-774
General Die Mold Co. 776
General Industries Co., The .. 622, 623
H & R Industries 769
Hyde, A. L., Co. 812
Ideal Plastics 628
Industrial Molded Products Co., Inc. 767
Johnson Glass & Plastic Corp. 760
Keolyn Plastics 766
Kingman, E. B., Co., Inc. 788
Leaf Plastics, Inc. 642
Lincoln Molded Plastics, Inc. 637
Lor-El Company 766
Makray Manufacturing Company .. 631
Michigan Plastic Products, Inc. 643
Midwest Molding and Manufacturing Company 792
Mimosa Corporation 785
Minnesota Plastics Corporation 627
Molded Products, Div. Admiral Corporation 777
Morningstar Corporation, The 797
National Plastic Products Co., The . 792
Norton Laboratories, Inc. 801
Northwest Plastics, Inc. 629
Owens-Illinois 624
Paragon Molding Co. 762
Penn-Plastics Corporation 814
Perry Plastics, Inc. 806
Plastic Molding Corporation 794
Plasticrafters, Inc. 761
Plura Plastics 798
Port Erie Plastics, Inc. 800
Presque Isle Plastics, Inc. 635
Pyro Plastics Corporation 647

Quinn-Berry Corp. 791
Recto Molded Products, Inc. 762
Richardson Company, The 638
Santay Corporation 795
Service Plastics, Inc. 784
Shaw Insulator Company 802
Sierra Electric Corp. 804
Sinko Mfg. & Tool Co. 802
Sobenite, Inc. 782
Standard Molding Corporation 624
Superior Plastics, Inc. 800
Sylvania Electric Products Inc., Parts Division 775
Tupper Corporation 778, 779
20th Century Plastics Co. 810
United States Gasket, Plastics Div., Garlock Packing Co. 790
Victory Manufacturing Corp. 815
Waterbury Companies, Inc. 641
Watertown Mfg. Co., The 637
Yardley Molded Plastics, Inc. 646
Zollinger, Albert, Inc. 756

METALLIZING

Cook, Lawrence H., Inc. 805
Erie Resistor Corporation, Plastics Division 809
Johnson Glass & Plastic Corp. 760
Sinko Mfg. & Tool Co. 802

MODEL MAKERS

H. M. S. Associates 814
Kingman, E. B., Co., Inc. 788

MOLD MAKERS

American Insulator Corporation .. 648
Artag Plastics Corp. 625
Atols Tool & Mold Corporation 643
Auburn Plastics, Inc. 808
Blackhawk Molding Co., Inc. 808
Boonton Molding Co. 634
Byrd Plastics, Inc. 759
Chicago Mold Engineering Co. 768
Chili Plastics, Inc. 776
Danielson Manufacturing Co., Div. Nicholson File Co. 783
Detroit Macoid Corporation 816
Detroit Mold Engineering Co. 645
Dillon-Beck Manufacturing Co. ... 644
Eagle Tool and Machine Co. 759
Engelking Patterns, Inc. 630
Federal Tool Corporation 776
General Die Mold Co. 776
General Industries Co., The .. 622, 623
Ideal Plastics 628
Industrial Molded Products Co., Inc. 767
Jay, T. V., Company 788
Johnson Glass & Plastic Corp. 760
Johnson Manufacturing Company .. 811
Kingman, E. B., Co., Inc. 788
Kuhn & Jacob Molding & Tool Co. 649
Liberty Tool & Machine Co. 792
Mack Molding Company, Inc. 640
Makray Manufacturing Company .. 631
Midland Die & Engraving Div., Prex Corporation 803
Midwest Molding and Manufacturing Company 792
Molded Products, Div. Admiral Corporation 777
Newark Die Hobbing & Casting Co. 765
Paragon Molding Co. 762
Perry Plastics, Inc. 806
Plating Engineering Co. 798
Precision Mold and Polishing Corp. 626
Presque Isle Plastics, Inc. 635
Recto Molded Products, Inc. 762
Reliance Pattern Works 800
Richardson Company, The 638
Service Plastics, Inc. 784
Sierra Electric Corp. 804
Sinko Mfg. & Tool Co. 802
Standard Molding Corporation 624
Stricker-Brunhuber Corp. 798
Tilp, J. G., Inc. 621
Victory Manufacturing Corp. 815
Waterbury Companies Inc. 641
Yardley Molded Plastics, Inc. 646
Zollinger, Albert, Inc. 756
Zapf, Charles, & Co. 756

MOLD POLISHING SERVICES

Electromold Corp. 812
Micron Specialties Company, Inc. .. 644
Nutmeg Chrome Corporation 794
Precision Mold and Polishing Corp. 624

PLUNGER MOLDERS

American Insulator Corporation ... 648
Consolidated Molded Products Corp. 807
Diemolding Corporation 768
Kurz-Kasch, Inc. 633
Plastic Molding Corporation 794
Waterbury Companies, Inc. 641

REINFORCED PLASTIC MOLDERS

American Insulator Corporaion 648
Consolidated Molded Products Corp. 807
General American Transportation Corporation, Plastics Div. ... 771-774
Insulation Mfg. Company, Inc. ... 816
Kurz-Kasch, Inc. 633
Molded Products, Div. Admiral Corporation 777
Penn-Plastics Corporation 814
Perry Plastics, Inc. 806
Plasticrafters, Inc. 761
Richardson Company, The 638
Waterbury Companies, Inc. 641

RESINS & MOLDING COMPOUNDS

Auburn Plastics, Inc. 808
General American Transportation Corporation, Plastics Div. .. 771-774
Marblette Corporation, The 780
Reynolds Chemical Products Co. . 812B

SHEETS, FILMS, RODS, TUBES

Ace Plastic Company 770
Busada Manufacturing Corp. 770
Carmer Industries 812C
Commercial Plastics Co. 815
Contour Extrusion Company 781
Detroit Macoid Corporation 816
General American Transportation Corporation, Plastics Div. .. 771-774
General Plastics Corporation 646
H & R Industries 769
Hyde, A. L., Co. 812
Midwest Plastic Products Company 797
Plastex Company, The 635
Plas-Tube Corporation 813
Rotuba Extruders, Inc., The, Div. Waljohn Plastics Inc. 806
Sandee Manufacturing Company 812A
Sheffield Plastics, Inc. 648
Sunlite Plastics Inc. 788
United States Gasket, Plastics Garlock Packing Co. 790
Vacuum Plastics Corporation .. 804
Yardley Plastics Company 814

SPECIAL SERVICES

Boonton Molding Co. 634
Carmer Industries 812C
Emeloid 793
General Industries Co., The .. 622, 623
Ideal Plastics 628
Johnson Glass & Plastic Corp. 760
Keolyn Plastics 766
Mchiigan Plastic Products Inc. 643
Morningstar Corporation, The 797
Victory Manufacturing Corp. 815

STOCK MOLDS

Davies, Harry, Molding Company .. 639
Rogan Brothers 802

STOCK PLASTIC CONTAINERS

Dillon-Beck Manufacturing Co. 644
Owens-Illinois 624
Plas-Tube Corporation 813

TAKE-OFF EQUIPMENT

Servospeed 763

TESTING SERVICE

Desert Sunshine Exposure Tests ... 760
South Florida Test Service 804

TRANSFER MOLDERS

American Insulator Corporation ... 648
Auburn Plastics, Inc. 808
Butterfield, T. F. Inc. 810
Diemolding Corporation 768
Insulation Mfg. Company, Inc. 816
Kurz-Kasch, Inc. 633
Mack Molding Company, Inc. 640
Northwest Plastics, Inc. 629
Penn-Plastics Corporation 814
Perry Plastics, Inc. 806
Plastic Molding Corporation 794
Plasticrafters, Inc. 761
Plastic Research Products Company, Div. Grimes Mfg. Co. 799
Recto Molded Products, Inc. 762
Richardson Company, The 638
Shaw Insulator Company 802
Trans-Matic Plastics Company 810
Watertown Mfg. Co., The 637
Zollinger, Albert, Inc. 756

VACUUM & SHEET FORMERS

Chili Plastics, Inc. 776
Consolidated Molded Products Corp. 807
Emeloid 793
General American Transportation Corporation, Plastics Div. ... 771-774
Lincoln Molded Plastics, Inc. 637
Plaxall, Inc. 789
Port Erie Plastics, Inc. 800
Vacuum Plastics Corporation 804
Watertown Mfg. Co., The 637

meet the **TILP** *worry bird . . .*



LET HIM DO ALL YOUR

PLASTIC MOLD

WORRYING FOR YOU

Do you have a mold problem? J. G. Tilp, Inc. can solve it for you

We have the know-how and the equipment to do the complete job

from design development to the finished construction of the mold.

. . . AND WE HAVE ALL THESE SERVICES UNDER ONE ROOF

Engineering
Engraving & Duplicating
Hobbing
Hard Chrome Plating

. . here are a few examples of our facilities—



1. Sales and Estimating Dept.



2. Engineering Dept.



3. Modern Engraving and Duplicating Dept.



4. Section of Frame Dept.



5. Efficient Delivery Scheduling



6. Final Inspection



Established 1918

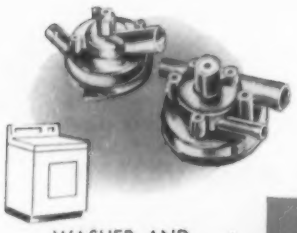
MUrdock 6-7300

Why not consult us regarding your next problem in plastics molding?
Our engineering staff will be glad to assist you.

J. G. TILP INC. UNION, N. J.

Superior Molds For Plastics Injection, Compression and Transfer

Mailing Address, Box 554, Union, N. J.



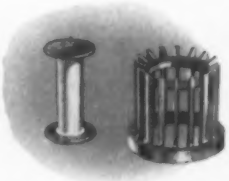
WASHER AND DRYER PARTS



APPLIANCE HANDLES



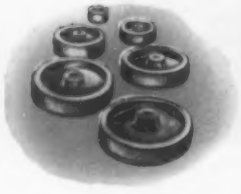
RADIO CABINETS



TEXTILE MACHINERY PARTS



CASH REGISTER DRAWERS



CASTERS



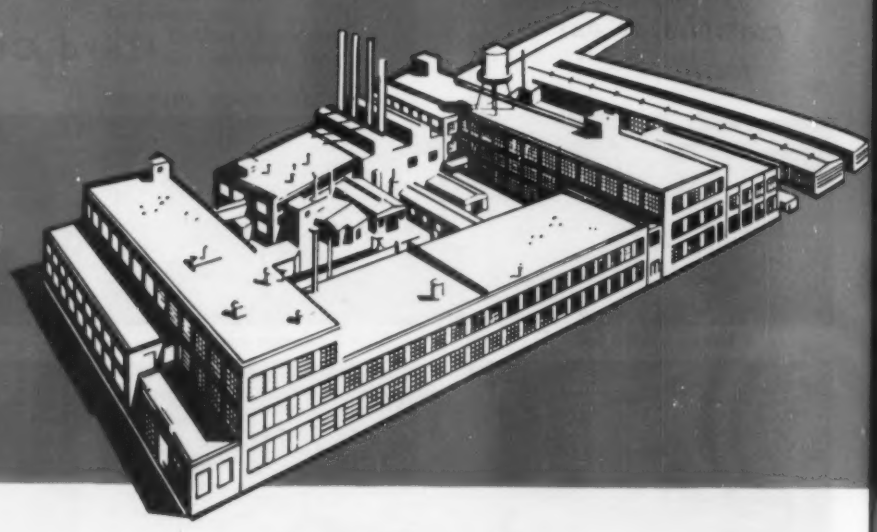
INDUSTRIAL GEARS

2 BIG REASONS WHY

Our TWO modern plants will *Efficiently*.....

1. ELYRIA, OHIO

In which is located General Industries' engineering and mold-making departments together with its extensive facilities for compression and transfer molding of thermosetting materials.



facilities

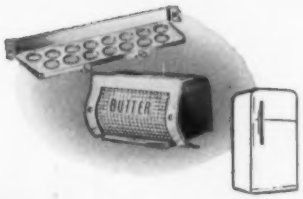
- **COMPLETE ENGINEERING SERVICE**
  Capable engineers, qualified by years of experience, to see that your designs are produced at lowest possible unit molding cost.
- **COMPRESSION MOLDING**
  180 various compression and transfer presses, most with top rams, ranging from 25 - ton to 1850 - ton capacity.
- **INJECTION MOLDING**
  16 modern injection molding presses ranging in size from 2 oz. to 200 oz. capacity for low cost, efficient production of thermoplastic materials of the highest quality in any quantity.
- **RADIO-FREQUENCY PREHEATING**
  One of the largest installations in the industry . . . more than 75 separate units to facilitate high-speed molding production.
- **CONVEYORIZED OPERATION**
  From press to shipping room, through finishing and assembly operations, entire operation conveyorized for fast, uninterrupted flow of molded parts.
- **FINISHING EQUIPMENT**
  Automatic facilities include equipment for trimming, polishing, buffing, drilling, tapping, tumbling and painting.



ELECTRICAL PARTS



GOVERNMENT WORK



REFRIGERATOR PARTS

IT PAYS TO RELY ON G.I.

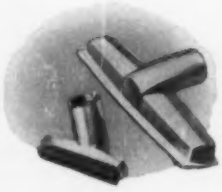
produce your custom molded plastics!

Economically..... On Time!

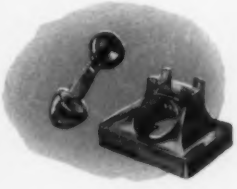


2. MARYSVILLE, OHIO

This modern Plant contains General Industries' greatly expanded facilities for injection molding of all thermoplastic materials.



VACUUM CLEANER NOZZLES



TELEPHONE SETS

experience

• Over the years, General Industries has engaged in the engineering and production of custom-molded plastics for many of America's largest manufacturers.

• Included among General Industries' current customers are the largest manufacturers of refrigerators and appliances, cooking utensils, telephones, cameras, textile machinery, automobiles and many other products.

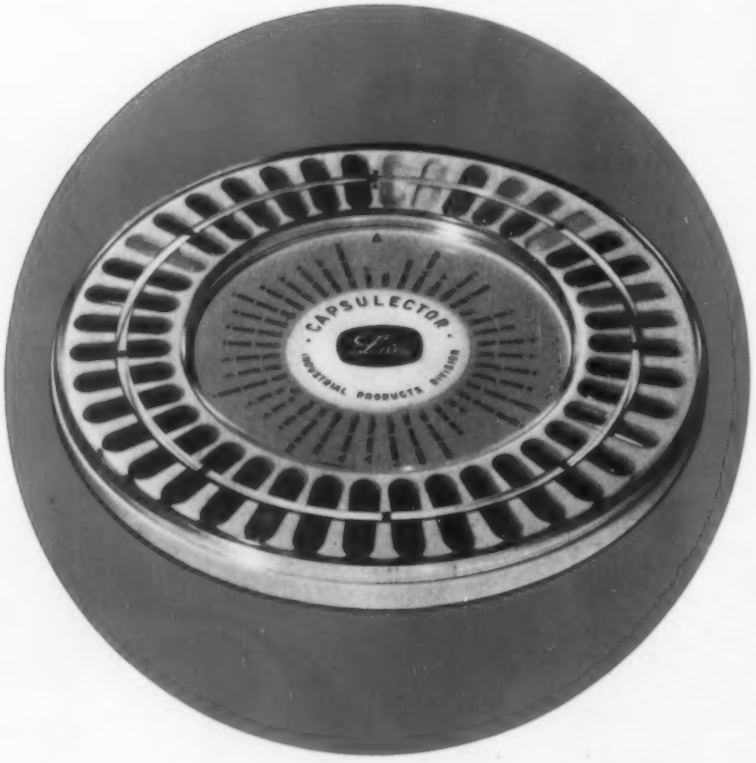
• Write or phone today for the services of our experienced Sales Engineers who will be happy to call on you and assist you with your engineering design and answer questions on your technical problems. General Industries will also conduct a survey at no cost to you of your product and advise you if you now have an item that can be made better and at a cost savings to you through conversion to the proper plastic material.

THE GENERAL INDUSTRIES CO.

Department PL • Elyria, Ohio

it is no secret–

Standard Molding Corporation products are the finest that can be obtained in the field of thermoplastic molding —however, fine production is just one of the many services offered by SMC of Dayton.



ideas–

Just an idea is all that is necessary to start SMC thermoplastic engineers and production experts working on your specific problem.

facilities–

SMC is equipped to handle any job which falls within the scope of thermoplastic molding—it is staffed to meet design and production schedules.

result–

Your ideas take form and become gratifying realities in a minimum of time—it is no wonder, then, that the Eli Lilly & Company of Indianapolis, Indiana, after having had previous satisfactory production experience with SMC, again turned to us for the development and production of the CAPSULECTOR, colorfully shown in the accompanying illustration.

let's review what happened–

Eli Lilly & Company sells empty gelatin capsules to other pharmaceutical companies—their packaging department needed a case to display their line of capsules, both in solid colors and in all the possible combinations of colors.

The idea for this case, along with some rough sketches, was presented to SMC early in the Spring of 1956. Immediately, SMC Engineers, in conjunction with representatives of the Lilly Packaging Development Department, started processing of designs and sketches which were accepted in July.

Two molds were begun, one for the inner and outer white parts and one for the clear part. By October of the same year, 1956, the tools had been sampled and the molded parts approved—production followed immediately.

Standard Molding Corporation is proud of this production achievement —is proud of the quality of the product and is proud of the trust that the Eli Lilly & Company places in our ability to create and produce the finest in thermoplastic molded products.

The solution of your problem may lie within the field of thermoplastics— You are invited to consult with our Engineers who will be glad to advise you concerning the potential of thermoplastics in relation to your needs.

SMC

STANDARD MOLDING CORPORATION

1517 East Third Street • Dayton 1, Ohio • HEmlock 8307

ARTAG



ARTAG'S modern block-long home is the answer to your ever increasing demands for our quality custom injection molding. Within these new walls are the same high standards of engineering "know-how," mold-craftsmanship, and molding technique that we have been known for these many years.

ARTAG PLASTICS CORPORATION / 2853 IRVING PARK ROAD / CHICAGO 18

WHAT A DIFFERENCE THE MOLD MAKES!...



A Perfect Reflection of Mold Polishing and Skill by Precision

Skill and experience make Precision's method of mirror-finished mold polishing second to none in the industry. Minute details are reproduced to meet the strictest specifications. All drafts and tapers are carefully checked to insure proper radii. Our proven procedures assure better cycles, more efficient mold operation and molded parts of superior finish.

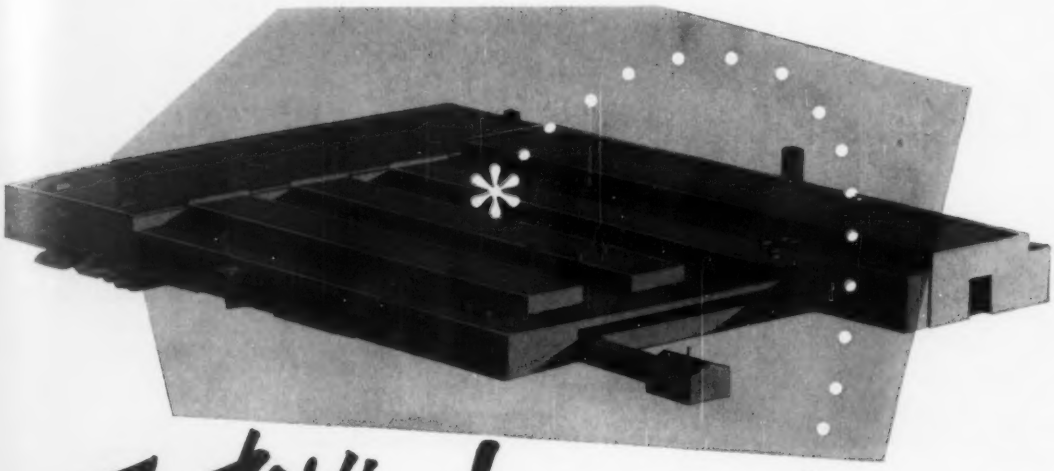
Why continue to wrestle with costly problems resulting from molds of inferior finish. Submit your specifications for quotations on mirror-sheen finishing for existing or contemplated molds. You'll find our charges reasonable and service prompt. Satisfaction guaranteed.



Precision Mold and Polishing

CORPORATION

P. O. BOX 322 • ROANOKE, VIRGINIA



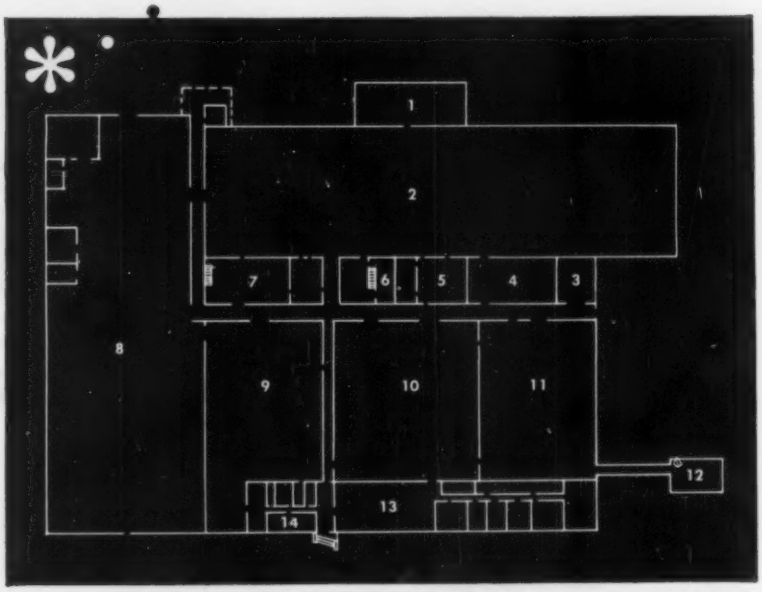
Factory Facts! about "Your plastics department"*

It is a new and complete injection molding plant, from modern tool room to all coordinated departments for supplementary operations such as assembly, decorative painting and printing and special packaging.

The quality and economy born of efficiency in a modern, custom operation are yours in our "start to finish service."

PLANT LAYOUT

1. Boiler and pump room
2. Molding room—32 presses 4 to 80 oz.
3. Air compressors
4. Lunch room
5. Shop maintenance
6. Employees locker rooms
7. Quality control
8. Warehouse and shipping dept.
9. Tool and die shop
10. Finishing and packaging
11. Decorative painting and imprinting
12. Paint and chemical storage
13. General offices
14. Drafting and engineering dept.



*MINNESOTA PLASTICS CORPORATION

Injection molders of thermoplastics

45 E. MARYLAND AVENUE ST. PAUL 3, MINNESOTA

"I Prefer to Have My Plastic Products Custom Molded by Ideal because..."

Here's how some of our customers completed this statement in twenty-five words or less:

RADIO MANUFACTURER



". . . Ideal's delivery of finished cabinets always is closely coordinated with our own production schedule."

REFRIGERATOR MANUFACTURER



". . . I find that Ideal gives us the realistic prices we seek without making any compromise on quality."

HOUSEWARES MANUFACTURER



". . . we frequently double or triple our orders to keep up with the changing market picture and Ideal has facilities to handle the production we want."

PREMIUM SPECIALTY HOUSE



". . . we have our product boxed at the molding plant and drop shipped, so we've got to rely on the honesty of our molder's inspection."

HOUSEWARES MANUFACTURER



". . . we depend on our molder to help choose the material for each of our products, and Ideal has given us wonderful help."

ADVERTISING NOVELTY COMPANY



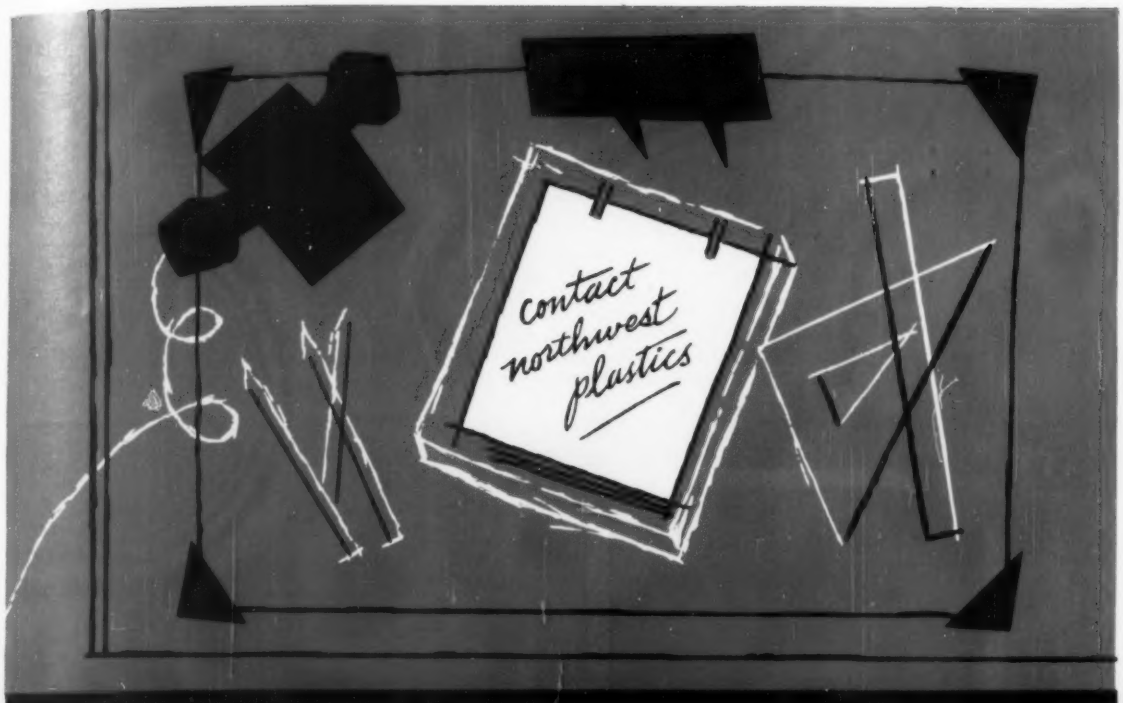
". . . they do a splendid job of assembling, painting, and decorating the many gadgets and signs we purchase."

Men who make the products and pay the bills appreciate the value of placing their custom injection molding in the competent hands of Ideal Plastics. Our reputation has been firmly established on thousands of satisfactory molding jobs.

Ideal's facilities for mold design and building, production control, molding, and assembling are second to none. For a prompt estimate, contact A. C. Manovill, Vice-President in Charge of Sales. Ideal Plastics, 184-10 Jamaica Avenue, Hollis 23, N. Y. Phone: AXtel 7-7000.

Ideal

Better Molded Plastics for Industry & Home



Your contact too—for precision custom molding

Let NORTHWEST PLASTICS take your custom molding job—from design through final production. Eighteen years of experience and the complete facilities of NORTHWEST PLASTICS are your assurance of expert production in compression, transfer, and injection molding. Convenient plants in Minnesota and North Carolina also mean *faster* service.

● *Contact your nearest NORTHWEST PLASTICS sales office today for full details.*

NORTHWEST PLASTICS, INC.
63 Plato Ave., St. Paul 7, Minn.
CApital 4-4728

NORTHWEST PLASTICS OF CAROLINA, INC.
Gastonia, North Carolina

Kansas City Sales Office
406 West 34th Street
Logan 1-7495

Chicago Sales Office
2030 W. Montrose Ave.
Lo 1-6831

Detroit Sales Office
1500 No. Woodward
Royal Oak, Michigan
Lincoln 7-7500

Milwaukee Sales Office
1130 North Water Street
Broadway 3-6318

Engelking's ABC of fine

Matched Metal Dies for Reinforced Plastics

Nothing approaches matched metal dies for rapid, precise, economical production of reinforced plastics. In the few short years of reinforced plastics molding, Engelking Patterns has made literally hundreds of sets of these dies for leading companies in all fields of endeavor.

The making of matched metal dies is a logical extension of Engelking's exacting wood pattern service. Starting from prints or drawings, Engelking performs every necessary step of die production in one of the Midwest's largest, best equipped pattern making and metal die making establishments. Key production equipment includes two Keller Duplicators, a BG-21 (6′ x 4′) and a BG-1 (5′ x 3′).

Write today for "The Story of Engelking" which explains our services in detail.

STEP 'A'



Making the Master Wood Pattern. Working from detailed blueprints, one of Engelking's master pattern makers transforms their flat instructions into an accurate 3-dimensional mahogany pattern. This premold mock-up has a dual purpose: it permits esthetic and engineering design analysis far more exacting than possible from prints alone, and it serves as the master for the Keller model.

STEP 'B'



Preparing the Keller Model. Shown here is half of a set of precise Keller models (one male, one female) made from the carefully finished wood pattern. Engelking prepares the models by building up over the pattern with a combination of glass cloth and special epoxy resin. When cured, these models act as "copy" for the Keller.

STEP 'C'



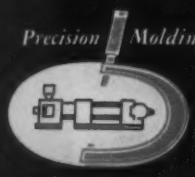
Kellering the Mold. The male epoxy-glass model is shown mounted on Engelking's 6′ x 4′ Keller where it is automatically traced and reproduced, contour for contour, in tool steel. A fine hand finishing operation readies it and its mate for molding. In this instance the reinforced plastics product is the housing for a popular outboard motor.

engelking
PATTERNS, INC.
COLUMBUS, INDIANA

give your plastic products the benefit of the

MAKRAY OK

Precision Molding

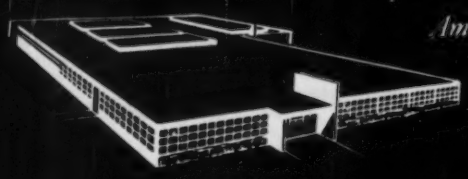


The Makray "OK" on your product is the result of a unique system of engineering, designing, molding and assembly room techniques that result in the best in plastics technology. But, while we are unique in the quality of painstaking craftsmanship and inspection that we apply to your products, we are completely competitive in price. Whether we originate the design or work from yours our objective is the same: To give you a plastic product that looks better, works better and sells better.

When you are in or near Chicago come out and visit us. You'll see why results are finer from America's finest injection molding plant. Or, call or write today for the complete story on the Makray "OK"



Precision-molded microphone for the new Comptometer Dictation Machine



America's finest, most modern plastic molding plant

- 24-hour operation assures speedy delivery
- 26 latest Hi-speed presses . . . 8 oz. to 60 oz. capacity
- Precision molds designed and built in our own shop
- Complete engineering service to serve you . . . save you money

MAKRAY MANUFACTURING COMPANY

Precision Plastic Molders

4400 North Harlem Ave., Chicago 31, Ill. • GLadstone 6-7100

NEW FULL LINE of Plastainer Vials by Owens-Illinois



Here is a random grouping of the full line of O-I Plastainer Vials. Available with Snap-Caps or Stoppers . . . in clear or a wide variety of colors . . . opaque or transparent . . . in 5 sizes—3, 5, 7, 9 and 13-dram (and 15-dram, stopper only). Each typifies the quality of the molding facilities at Owens-Illinois. Call your nearest O-I office for details.

Branch Offices:

Albany . . . New York	Dallas . . . Texas	Memphis . . . Tennessee	Portland . . . Oregon
Atlanta . . . Georgia	Denver . . . Colorado	Milwaukee . . . Wisconsin	Richmond . . . Virginia
Baltimore . . . Maryland	Detroit . . . Michigan	Nashville . . . Tennessee	Rochester . . . New York
Birmingham . . . Alabama	Elkhart . . . Indiana	New Orleans . . . Louisiana	Sacramento . . . California
Boston . . . Massachusetts	Fresno . . . California	New York . . . New York	St. Louis . . . Missouri
Buffalo . . . New York	Hartford . . . Connecticut	Oakland . . . California	St. Paul . . . Minnesota
Charleston . . . West Virginia	Houston . . . Texas	Oklahoma City . . . Oklahoma	Salt Lake City . . . Utah
Charlotte . . . North Carolina	Indianapolis . . . Indiana	Omaha . . . Nebraska	San Francisco . . . California
Chicago . . . Illinois	Jacksonville . . . Florida	Peoria . . . Illinois	Seattle . . . Washington
Cincinnati . . . Ohio	Kansas City . . . Missouri	Philadelphia . . . Pennsylvania	Toledo . . . Ohio
Cleveland . . . Ohio	Los Angeles . . . California	Pittsburgh . . . Pennsylvania	Yakima . . . Washington
Columbus . . . Ohio	Louisville . . . Kentucky		

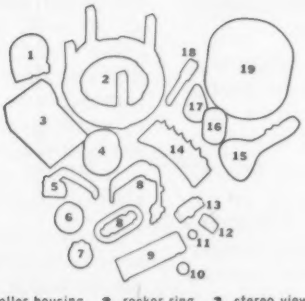
Pacific Coast Headquarters, 350 Sansome St., San Francisco . . . Plants at San Jose, Calif., St. Charles Ill., Glassboro, N. J., and Riverdale, N. J.

OWENS-ILLINOIS PLASTICS
AN (I) PRODUCT

OWENS-ILLINOIS
GENERAL OFFICES • TOLEDO 1, OHIO



prime source for molded parts



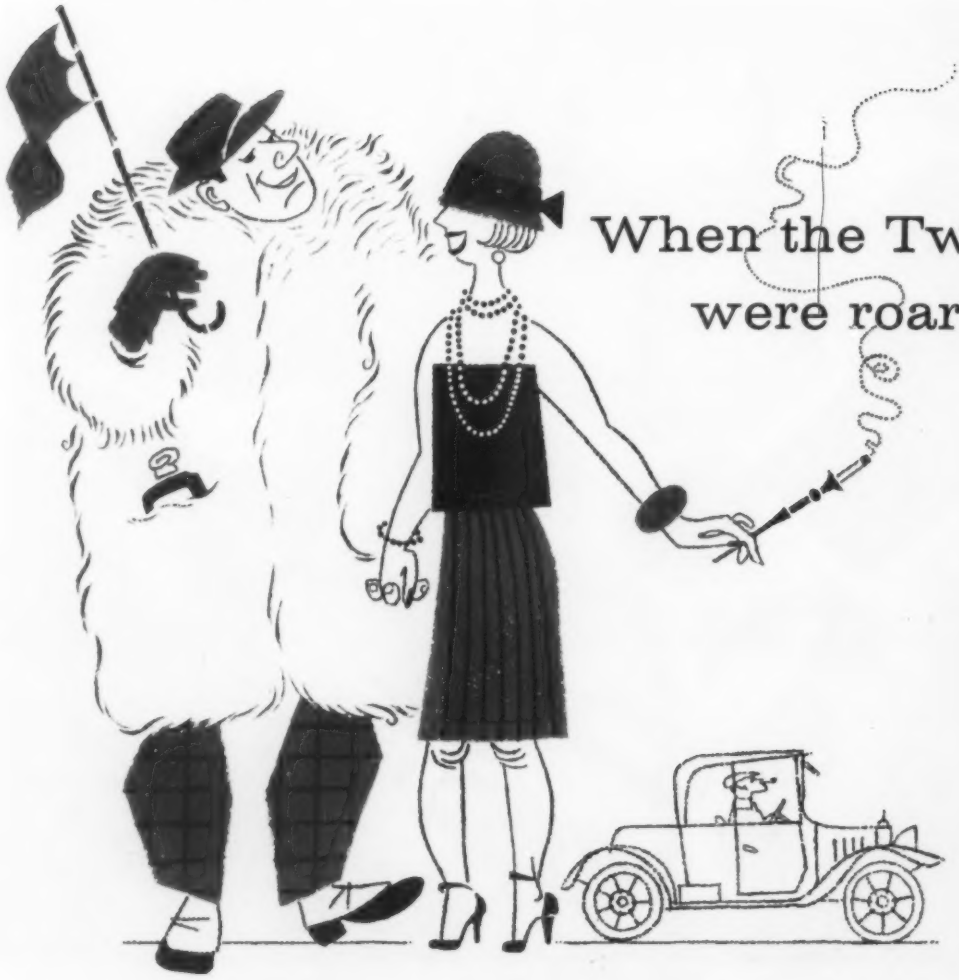
1. impeller housing. **2.** rocker ring. **3.** stereo viewer. **4.** fuse nose. **5.** appliance handle. **6.** and **7.** knobs. **8.** and **9.** terminal boards. **10.**, **11.**, and **12.** miniaturized parts. **13.** organ key. **14.** terminal board. **15.** spinning reel handle. **16.** valve liner. **17.** fuse nose. **18.** organ key. **19.** blower wheel.

For three good reasons, Kurz-Kasch is a prime source for molded thermosetting plastic parts. *First: money-saving experience.* The parts shown illustrate our breadth of experience and capacity for handling difficult jobs. *Second: money-saving tooling.* We design tools and dies for best long-run production economy. *Third: money-saving deliveries.* You get believable promise dates and your parts arrive on schedule. Call your nearest representative for a quote on your next job. Kurz-Kasch, Inc., 1415 South Broadway, Dayton 1, Ohio.

kurz-kasch

SPECIALISTS IN **THERMOSETTING PLASTIC PARTS** FOR 41 YEARS

SALES OFFICES—New York, Mt. Vernon, Mo 4-4866; Rochester, Hillside 0626; Beverly, Mass., Walker 2-0065; Chicago, Merrimac 7-1830; Detroit, Jordan 6-0743; Philadelphia, Hilltop 6-6472; Dallas, Lakeside 6-5233; San Gabriel, Cal., Atlantic 7-9633; St. Louis, Parkview 5-9577; Atlanta, Cedar 7-5516; Toronto, Can., Oliver 7986



When the Twenties were roaring . . .

there were flappers, vamps, and "Oh, you kid," raccoon coats, the Model T, and "Twenty-three skiddoo." There was also a company named Boonton, custom molding plastics over in Jersey.

Now it's plastics that's roaring, and the fads of the Twenties have pretty much skiddooed. But Boonton's still custom molding plastics over in Jersey.

By this time, though, we've become pretty big in the industry—with an entire plant for compression molding, another for injection molding, still another for Boontonware (that's our famous line of molded dinnerware), and facilities for designing, finishing, assembling, and hot stamping.

We've also added a Special Products Division, as well. This division is set up to handle all the problems that require special ingenuity to solve. It might be the design and production of a piece for an unusual application, or one that doesn't lend itself to standard compression and injection methods. We use such techniques as casting . . . potting . . . low pressure molding . . . dipping . . . and electronic assembly. All this, of course, in addition to our regular compression and injection molding service.

As you can see, we can handle just about any job. Yours too, probably. So get in touch with us, won't you? You don't even have to knock three times and whisper, "Joe sent me." Write . . . wire . . . phone . . . or shout—if you're close enough.

BOONTON MOLDING CO.

BOONTON, NEW JERSEY

New York Metropolitan Area—Cortlandt 7-0003
Western New York Area—Alden 7134
Connecticut Area—Woodbine 1-2109 (Tuckahoe, N. Y.)
Philadelphia Area—Pioneer 3-0315



make us your dependable source for

EXTRUDED PLASTICS

Designing, Engineering, Die Making and Precision Production to your exact specifications, of:
VINYLS · ACETATES · ACRYLICS
BUTYRATES · POLYSTYRENES
POLYETHYLENE · ETHYL CELLULOSE
in rigid and flexible shapes. Sheet stock for vacuum forming in widths to 36"—.040 to .100 thickness.
Producers of highest quality extrusions since 1939.

PLASTEX PIPE



Famous Plastex Pipe and Fittings in sizes from ½" to 6". Every coil individually wrapped —with rip cord opener. Purity attested by the National Sanitation Foundation seal of approval.

PLASTEX PANEL

The beautiful and durable finish for every wall, in lovely decorator colors. Panels 12" x 96". Matching trim strips.
For complete information, write

PLASTEX SINCE 1939
THE PLASTEX COMPANY
Dept. M, 3232 Cleveland Ave.
Columbus, Ohio
Phone AMherst 7-5407

QUALIFIED

INJECTION MOLDERS

Complete facilities to handle all injection molding problems cover our 54,400 square feet of modern plant.

Our molding equipment consists of 16 presses: one-4 oz. Lester and one-4 oz. Reed Prentice, one-6 oz. Reed Prentice, one-10 oz. Reed Prentice, one-12 oz. W. S., four-16 oz. W. S., one-22 oz. W. S., one-32 oz. W. S., two-48 oz. W. S., one-16 oz. Reed Prentice, one-28 oz. W. S., one-90 oz. W. S. (Preplasticizing Type).

We have the latest equipment in our Finishing Department and Tool Shop and are very well equipped in every department to handle any or all jobs up to 90 oz.

Our Engineering Department has knowledge and experience from original design to finished product. Some large castings molded include gun stocks, toilet seats, vacuum cleaner, refrigerator and television parts, etc.

Our customers include the biggest names in industry.

Prospective customers are invited to inspect our plant and facilities.

Presque Isle Plastics, Inc.

2730 WEST 12TH ST., - ERIE, PENNA.

CUSTOM MOULDERS

LARGE OR SMALL CASTINGS

SPECIFY Lincoln MOLDED PLASTICS TODAY

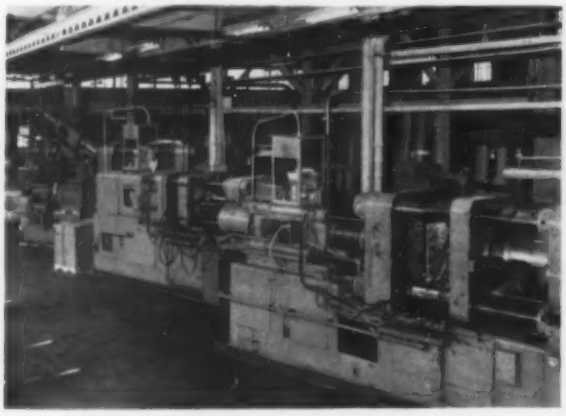
. . . FOR YOUR PRODUCTS OF TOMORROW

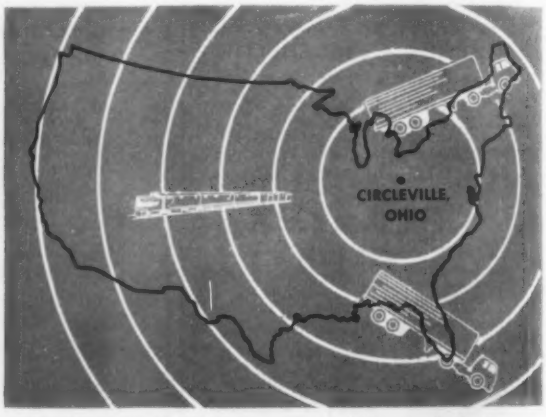




WIDE RANGE OF EXPERIENCE– Lincoln Molded Plastics, Inc. has a wide range of experience in designing, engineering and producing a large variety of "Tomorrow-styled" thermoplastic products and components. Lincoln produces crisper drawers, escutcheons, inside freezer doors, radio cabinets, air conditioner parts and other ornamental items for 9 of the top 11 appliance manufacturers, as well as many other types of products for numerous other manufacturers.

TECHNICAL "KNOW-HOW"– Lincoln's experienced staff of designers and engineers have the technical "know-how" to develop designs, from your first inspiration through the finished product. Or we can take over at any phase in the development of your design and carry it to completion. Our engineering field service saves you time, and your inquiries are handled accurately and promptly.





COMPLETE FACILITIES– Lincoln's injection molding and vacuum-forming extrusion facilities are modern up-to-the-minute, and complete. Our quality control system requires close adherence to rigid standards, which insures you plastic components of the finest quality.

PROMPT DELIVERY– You get prompt delivery of plastic components anywhere in the Nation; first, because of our large and complete facilities we are able to provide fast service and second, because we are ideally located in the industrial heart of the nation.

If you're looking for a *reliable* source of supply, with design know-how and a wide range of experience in the thermoplastics field, to engineer and produce a variety of thermoplastic components for new or restyled products, check Lincoln Molded Plastics, Inc. WRITE TODAY for "Development and Progress" a FREE catalog fully describing the facilities of Lincoln Molded Plastics, Inc., Circleville, Ohio.

Lincoln helps you create and produce more of tomorrow today.

L M P **Lincoln**

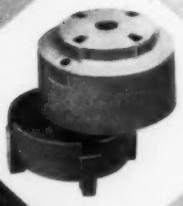
MOLDED PLASTICS, INC. • CIRCLEVILLE, OHIO

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

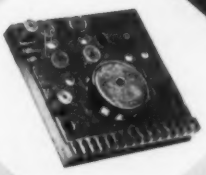
CUSTOM
PLASTIC PARTS



FROM DESIGN
TO DELIVERY



COMPRESSION,
INJECTION,
TRANSFER
MOLDING





VACUUM FORMING

ANY
THERMOPLASTIC
OF THERMOSETTING
MATERIAL



ANY SIZE
OR SHAPE

AT A PRICE
YOU'LL LIKE



43 YEARS
EXPERIENCE

WRITE:
THE WATERTOWN
MFG. CO.

300 ECHO LAKE RD.
WATERTOWN, CONN.

RICHARDSON

helps improve molded auto parts

Each of the molded parts pictured here had specifications which called for special materials often with unusual properties. All called for creative design approaches, both by customer and Richardson.

Richardson engineers, specialists in both molded and laminated plastics, will welcome the opportunity to help you. Write or phone for additional information.

THE RICHARDSON COMPANY
FOUNDED 1858
2747 Lake St., Melrose Park, Ill. (Chicago District)


MELROSE PARK, Ill.


INDIANAPOLIS, IND.

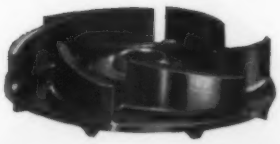
SALES OFFICES IN PRINCIPAL CITIES


NEWNAN, GA.


NEW BRUNSWICK N. J.


OGDEN, UTAH


TYLER, TEXAS



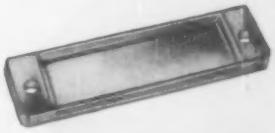
. . water pump impeller A special moisture resistant phenolic was specified for this part which must withstand the extremes of both high heat and intense cold, as well as strong torque action plus corrosion and cavitation resulting from the circulation of water in the car's cooling system.



. . timing gear The molded blank of this gear had to have high flexural characteristics . . also a good bond in the laminate section for ease in cutting gear teeth, and to insure necessary tooth strength. The manufacturer and Richardson developed a new material with high heat resistance. Result: Fine flexural strength in the web section . . more quiet operation . . . easier fabrication . . . easier assembly . . . *tripled gear life!*



. . radio antenna mast base This part had to have good surface appearance, high impact strength, high dielectric strength, and at the same time be weather resistant. A black phenolic material with an attractive high gloss finish was recommended.



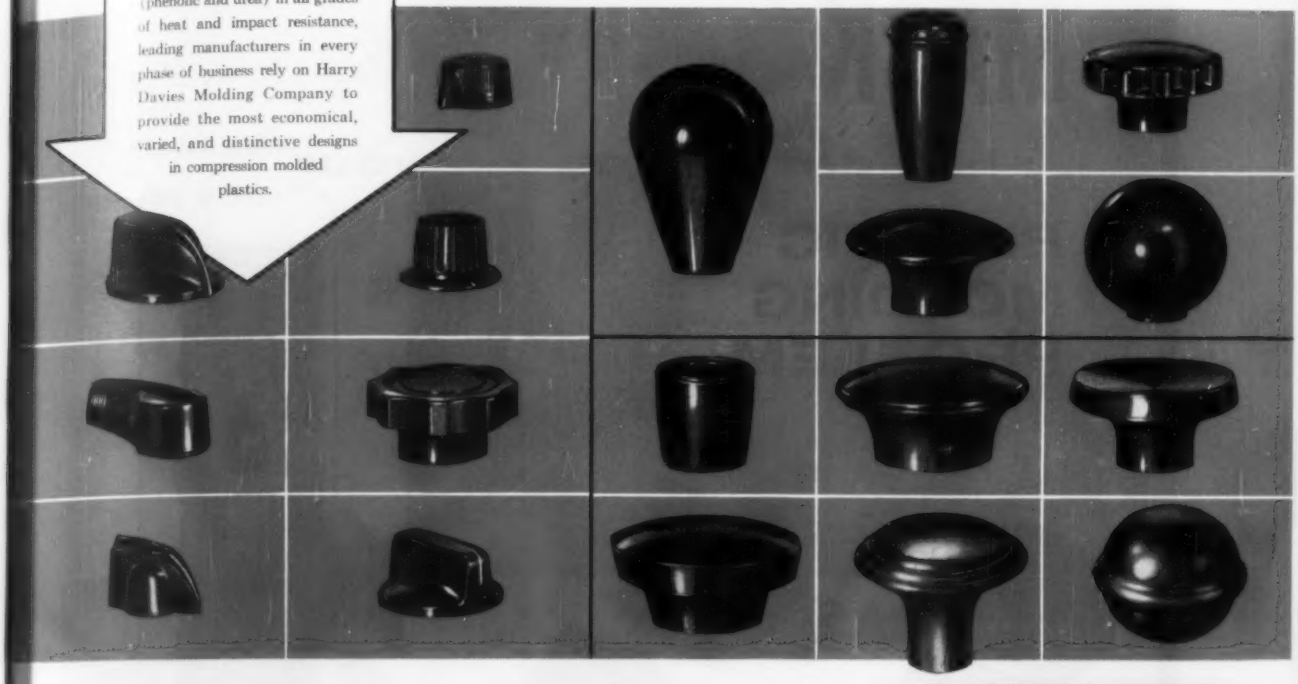
. . dashboard light lens Originally this part was designed as a clear lens. Later, when the specifications were changed to call for a translucent lens, the customer suggested that either the mold, or the clear parts, be sandblasted. . either process would have increased costs. Richardson suggested, instead, a special light-transmitting polystyrene. Result: 15% reduction in lens cost.

RICHARDSON PLASTICS
MOLDED AND LAMINATED

More than 3500 variations of 275 Stock Mold Parts

MAKE YOUR PRODUCT DISTINCTIVE *at no extra cost*

For diversity in standard parts of thermosetting materials (phenolic and urea) in all grades of heat and impact resistance, leading manufacturers in every phase of business rely on Harry Davies Molding Company to provide the most economical, varied, and distinctive designs in compression molded plastics.



plus **25 YEARS EXPERIENCE IN CUSTOM MOLDING**

to the most exacting specifications

To the individual efforts of our experienced engineers and tool makers in successfully producing the most complex custom molds, the Harry Davies Molding Company adds superior production facilities, ultra-high speed machinery, and unlimited know-how in the field of thermosetting plastic materials.



You Can Save Thousands of Dollars By Use of These Combined Facilities

SEND FOR FREE CATALOG TODAY!

Without obligation, send me your new catalog of stock mold parts.

name_____

company_____

address_____

city and state_____

HARRY DAVIES MOLDING COMPANY

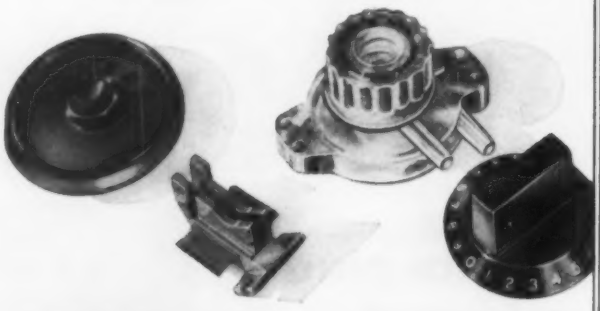
Makers of DAKA-WARE Products

1428 North Wolcott Street, Chicago 10, Illinois • Offices in Boston, Seattle, New York, Philadelphia, St. Louis, Los Angeles, Milwaukee, Columbus (Ind.), Buffalo, Lansing, Cleveland, Memphis, Louisville, Dallas, and Toronto

MACK

has designs on your

PLASTIC MOLDING PROBLEM





From Designing to Final Inspection... Over 35 Years of Specialization Assures the Quality of Your Plastic Components

Mack Custom Molding Service

Includes the facilities of three completely equipped plants. Mack design and production engineers are familiar with the problems involved in molding intricate precision industrial parts and functional components for consumer products.

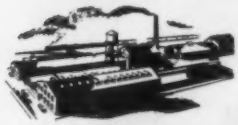
From Blueprint to Delivery

Mack will work with you from the planning stage right through to final delivery. For assistance on specific requirements, just call or write: Mack Molding Company, Inc., Wayne, New Jersey.

Serving Industry for Over 35 Years

MACK
Molded Excellence

Three plants to help with your plastic problems:



• WAYNE, NEW JERSEY



• ARLINGTON, VERMONT

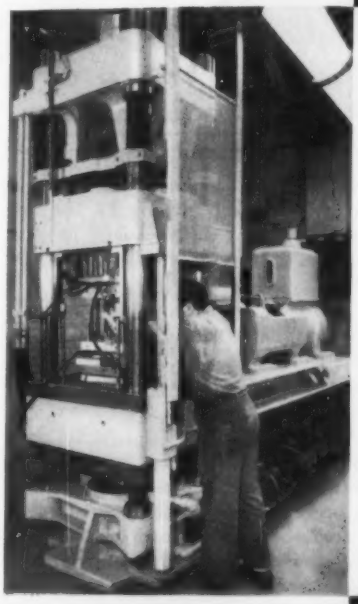


• WATERLOO, P.Q., CANADA

Craftsmanship

IN MAKING THE MOLD DETERMINES THE QUALITY OF THE MOLDED PRODUCT





At Waterbury traditional, painstaking craftsmanship, together with the latest, most improved machine tools, combine in the tool room to produce excellence in the molded plastic part or product.

This heritage of craftsmanship, and our long, uninterrupted experience in working with the modern miracles of plastic compounds, is always at your service.

WATERBURY *Companies, Inc.*

ESTABLISHED 1812

PLASTIC MOLDING · METAL PARTS **METAL BUTTONS**

WATERBURY 20, CONNECTICUT **PLAZA 6-5551**

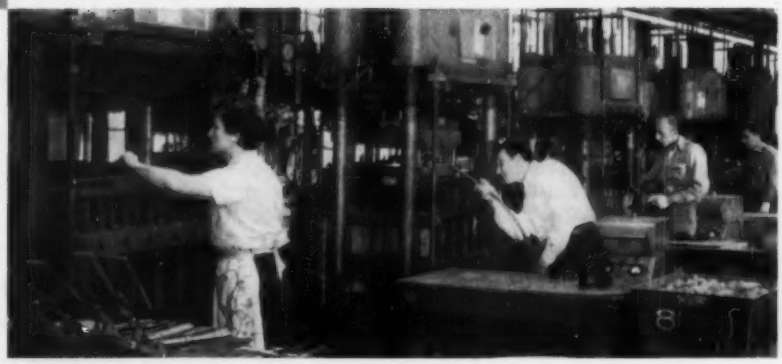
53 COMPRESSION PRESSES
up to 700 ton

19 HIGH SPEED PLUNGER PRESSES
up to 300 ton

17 INJECTION MACHINES
up to 32 oz.

Automatic Compression Presses
Low Pressure Fiberglass Presses
Preforming Equipment
Complete Finishing Facilities

ENGINEERING and DESIGN
RESEARCH **ASSEMBLY**
METAL INSERTS



Looking for an injection molder

with experience on a wide range of products?

Leaf Plastics has produced just about every type of injection molding for some of the largest users of plastics.

We've accumulated considerable experience turning out molding for INDUSTRIAL, COMMERCIAL and MILITARY applications.

In addition to our injection molding facilities, we're set up for

- FINISHING
- ASSEMBLY
- DECORATING
- PACKAGING

Consult our technical staff on your injection molding needs. Simply send us a sketch or print of the required part, and we'll give you a detailed estimate, without obligation, of course.



LPI **LEAF PLASTICS** INCORPORATED

135 Woodworth Avenue
Yonkers, New York

Investigate the packaging field—

IT'S A BIG MARKET FOR PLASTICS!

"Big Market," is right! The men who select the materials used to package the output of America's biggest industries control a market that will hit the 15 billion dollar mark this year.

Typical of the 45 industries that comprise this rich market are companies which manufacture and package foods, cosmetics, chemicals, drugs, candies and tobacco products. In all these highly competitive industries frequent packaging changes are the order of the day. Factors ranging from fascinating sales appeal to plain hard costs influence the men who make the packaging decisions. Consequently, no one type of packaging material (glass, metal, paper or fabric) ever has assurance that it won't be supplanted by another.

And now plastics have entered the arena as directly competitive materials for packaging. In just the last few years they have come to play an increasingly important role—and often at the expense of older, "traditional" materials.

Especially noteworthy is the fact that plastics can be used in the manufacture of almost every basic package type: box, bag, bottle, drum, jar, vial or collapsible tube!

Right now this frontal invasion of the packaging field by alert plastics manufacturers, molders, laminators and fabricators has just begun. And their chief sales tools are the two publications which reach the men who make packaging decisions in all 45 industries—MODERN PACKAGING magazine, issued monthly, and the annual MODERN PACKAGING ENCYCLOPEDIA ISSUE.

Free Details about the Market

Additional data on using these media to help expand your sales to the packaging market are contained in the booklet "The Packaging Field—and how to reach it." Write for your free copy.

•

MODERN PACKAGING

575 MADISON AVENUE NEW YORK 22, N. Y.

ATOLS

TOOL AND MOLD CORPORATION

DESIGNERS & FABRICATORS

of

QUALITY MOLDS

for the

PLASTICS INDUSTRY

Complete designing and engineering. Modern plant & equipment includes BG-21 4' x 6' & BL-3620 Keller Duplicators.

5005 West Armitage Ave.
Chicago 39, Ill.
BErkshire 7-0800

DESIGNED
ENGINEERED
PRODUCED

3 STEPS THAT LEAD TO ONE CONCLUSION . . .

MICHIGAN PLASTIC PRODUCTS, INC.

has the complete facilities to follow thru with your molding problems from idea to end product



PRODUCTS IN WHICH MICHIGAN PLASTIC MOLDED PARTS ARE USED

- Automobiles
- Refrigerators and Freezers
- Automatic Washers and Dryers
- Juke Boxes
- Juvenile Furniture
- Displays and Novelties

At Michigan Plastic Products, Inc. modern specialized equipment in the hands of experienced craftsmen assures you of custom quality at competitive prices. All phases of designing, engineering and production are handled under one roof, including molding, assembly, painting and finishing.

Specialists in injection molding of thermo-plastic materials, Michigan Plastic Products, Inc. is equipped with eight Reed-Prentice injection machines ranging in capacity from 4 ounce thru 32 ounce.

If your product requires a practical, low cost plastic part, designed and delivered from one source, write or call Michigan Plastic Products, Inc. today!

MOLDERS OF

FINE PLASTIC PRODUCTS

MICHIGAN PLASTIC PRODUCTS, INC.

GRAND HAVEN, MICHIGAN

PHONE 2940

sales office:

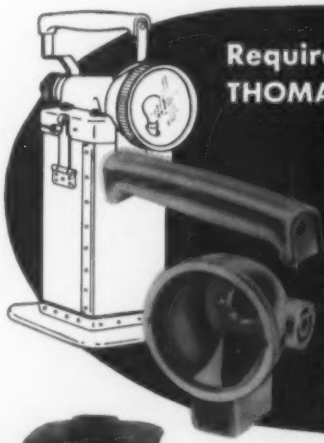
45834 VanDyke, Utica, Mich. Phone Republic

IMPROVE YOUR PRODUCT
WITH CREATIVE MOLDING BY

DILLON-BECK

SPECIALISTS IN CUSTOM MOLDING
AND PLASTIC PACKAGING

Creators of molded parts and distinctive plastic containers for varied industries including pharmaceutical, electronics, food, hardware, toy, cosmetics, sporting goods.



Required by
THOMAS A. EDISON INDUSTRIES
EDISON STORAGE BATTERY DIVISION

Break-resistant, light-weight, easily-assembled parts for their subway lamp with closely held thread tolerances, uniform molding of heavy sections, lustrous finish. These key injection molded components with complicated draw core molding were

PRODUCED to PERFECTION by DILLON-BECK



Required by
TREMEN ELECTRONICS
Manufacturing Corp.

Light-weight, break-resistant plastic container of unusually deep draw for "Teamco Blend Chief".

DESIGNED, MOLDED and PRODUCED to PERFECTION by DILLON-BECK

★

THE WHOLE WAY From idea to design to finished product, you can count on Dillon-Beck for "Something Special" in injection molding. Our Design and Engineering Staff will help re-style your present product.

- **Designs and Models Prepared and Furnished.**
- **Mold and Die Construction Department.**
- **Molding and Assembly of Thermoplastics ranging from 1 to 16 oz.**

D B

YOUR INQUIRIES INVITED

DILLON-BECK Manufacturing Co.
Designers • Molders of Plastic Products
1227 CENTRAL AVE., HILLSIDE, NEW JERSEY

FAST FACTS ABOUT Mold Polishing

FACT A

Once you experience the speed and economy of Micron polishing, you will know it rarely pays to tie up your own expensive moldmakers on time-consuming mold polishing operations.

FACT B

Fine custom mold polishing by a specialist — like Micron — costs less and takes less time than doing the same job in your own shop.

FACT C

Micron polishing does more than hide defects and blemishes... it actually removes them. Molds mirror-finished by Micron produce

- faster cycles
- excellent surface finish
- highest optical properties for transparent parts

Molds chrome plated, as required, to preserve finish during long runs.

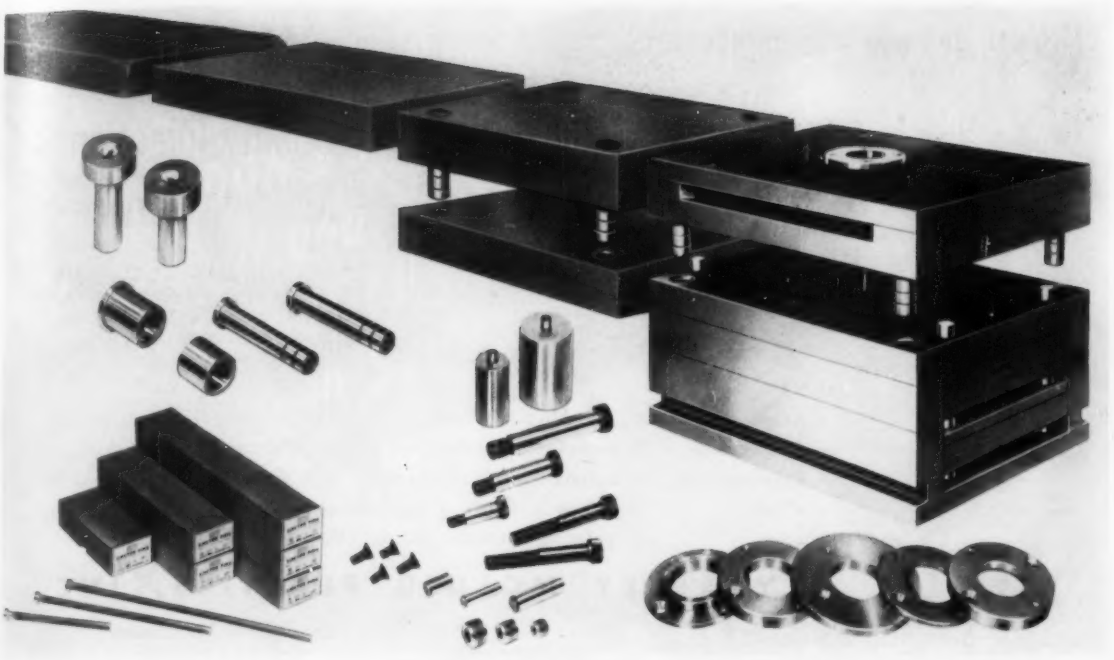
FACT D

Micron mold polishing craftsmanship is employed by critical molders and moldmakers in all parts of the country. Micron speed, economy and results are unsurpassed.

Quotations furnished from blueprints or sample shots.

A full line of polishing supplies and diamond compounds.

MICRON
SPECIALTIES
COMPANY, INC.
"Make It Better With Micron"
4253 W. Fullerton Ave., Chicago, Ill.
Phone: Albany 2-8305



PROGRESS THROUGH STANDARDS

. . . and how DME "helped"

The history of economy in modern business has been directly related to the history of Standardization. One of the major elements affecting the economic production of finished plastic parts is the high initial cost of the mold. A progressive step in reducing mold cost, without sacrificing the high quality required, has been successfully achieved through Standardization.

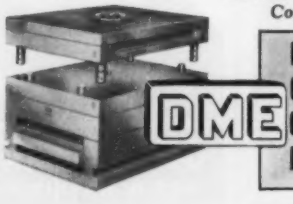
When D-M-E originated Standard Mold Bases and their component parts in 1942, it provided the answer to the rapidly growing demand for high quality molds that would maintain and promote the economic advantages of plastic parts.

Through large volume purchases of quality steel in standard sizes and specialized production facilities, D-M-E was able to produce and supply high quality Standard Mold Bases to mold makers and molders at such great savings in cost and time that the benefits of Standardization were quickly realized by the Industry.

Today D-M-E produces twenty-eight different sizes of Standard Mold Bases, from 9" x 8" to 23¾" x 35½", in either D-M-E No. 1 or No. 2 Steel, with a wide range of cavity plate thicknesses to satisfy the diversified demands required. In addition, over 2,000 finished component parts of the same high quality are available to provide additional savings in service as well as in the product.

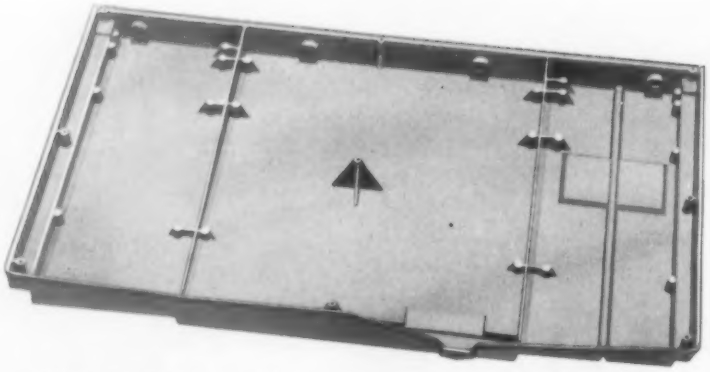
Properly engineered Standardization puts the accent on Economy. When you "Specify D-M-E . . ." you get Quality, Service AND Economy!

Specify **D-M-E**
for
QUALITY . . .
SERVICE . . .
ECONOMY!



DETROIT MOLD ENGINEERING CO.
6686 E. McNICHOLS ROAD — DETROIT 12, MICHIGAN — TWinbrook 1-1300
Contact Your Nearest Branch FOR FASTER DELIVERIES!

HILLSIDE, N. J. (NEAR NEWARK) 1217 CENTRAL AVE., ELIZABETH 3-5840
CHICAGO 51, ILLINOIS 5901 W. DIVISION STREET, COLUMBUS 1-7855
CLEVELAND 9, O. - D-M-E CORP. 502 BROOKPARK RD., SHADYSIDE 1-8202
LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214



YARDLEY

Quality Injection Molding Service

• PRODUCT DESIGN • COMPLETE ENGINEERING • MOLD BUILDING
• 20 PRESSES — 4-OZ. TO 60-OZ. CAPACITY — BOTH VERTICAL AND HORIZONTAL

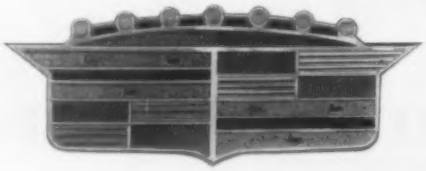
All thermoplastic materials:

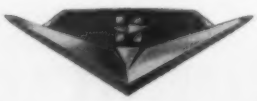
- Styrene
- Nylon
- Acetate
- Butyrate
- Acrylics
- Polyethylene
- Ethylcellulose
- Vinyls
- Impact materials

Yardley offers you both wide experience and vast manufacturing facilities in the production of appliance and automotive parts, housings, pipe fittings, etc. Equipped for complete finishing operations including fabrication, spray painting, vacuum plating, etc.

YARDLEY MOLDED PLASTICS, INC.

Parsons and Town Streets
Columbus 15, Ohio





For prompt quotations send specifications and detailed drawings

---



In Your Mind's EYE . .

. . . YOU'RE probably visualizing a plastic product that would be useful—*and* saleable.

WE'RE ready to help—with design assistance assuring your product functional perfection plus sales appeal. We'll produce it, too—expertly and at low cost.

Let's get together!

Connecticut Plastic Products Company
70 West Liberty St. Waterbury, Conn.

GENCO QUALITY
FORMABLE SHEETING
FOR THE FABRICATOR

HIGH IMPACT STYRENE
ACRYLIC
ACRYLONITRILE COPOLYMER STYRENE
CELLULOSE ACETATE BUTYRATE

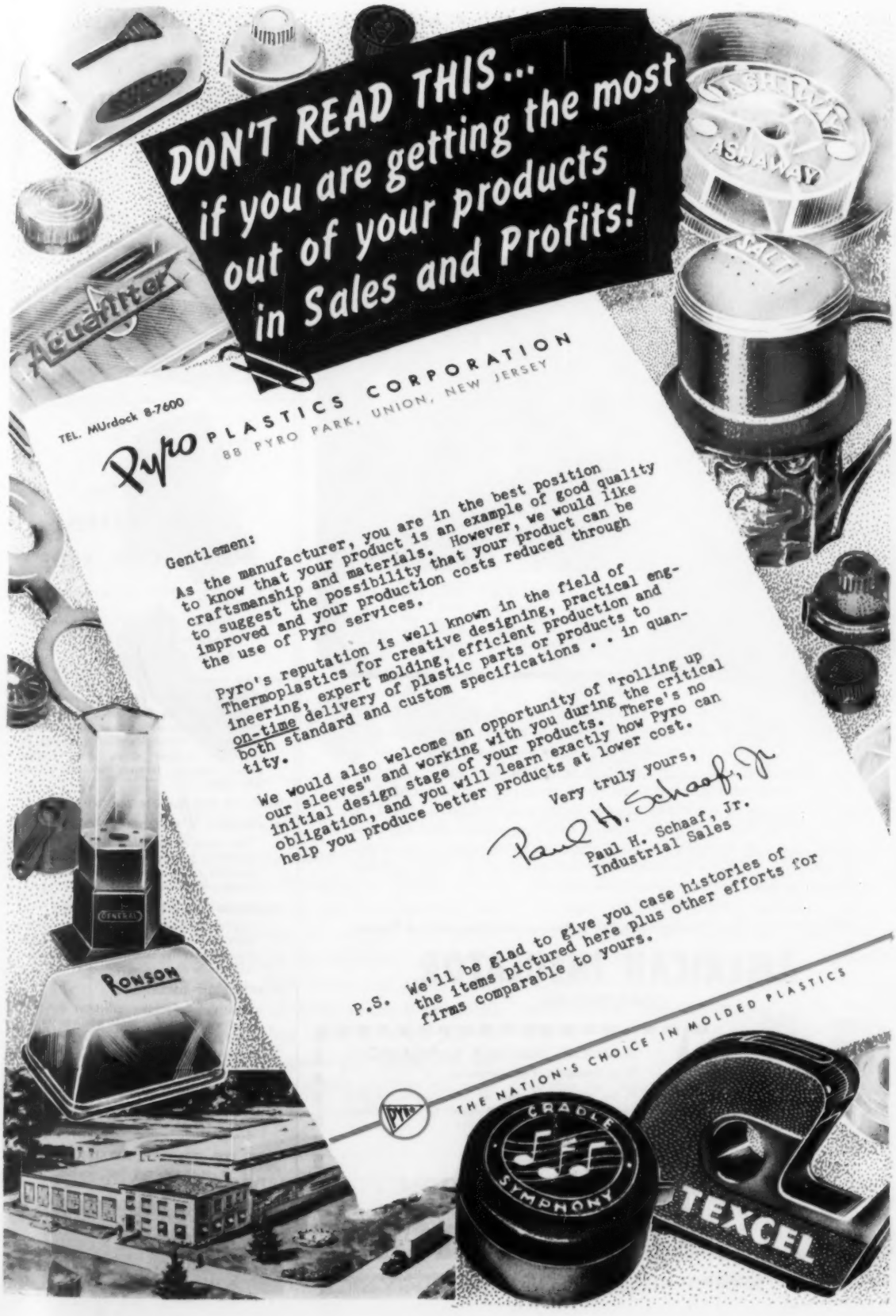
GENERAL PLASTICS CORPORATION

up to 48" width
light to heavy gauge

SHEETING TO ORDER IN A FULL RANGE OF COLORS
transparent • translucent • opaque

CUT TO SIZE · · · · ALL FORMULATIONS FOR
VACUUM FORMING

GENERAL PLASTICS CORPORATION
1400 N. WASHINGTON ST. MARION, INDIANA

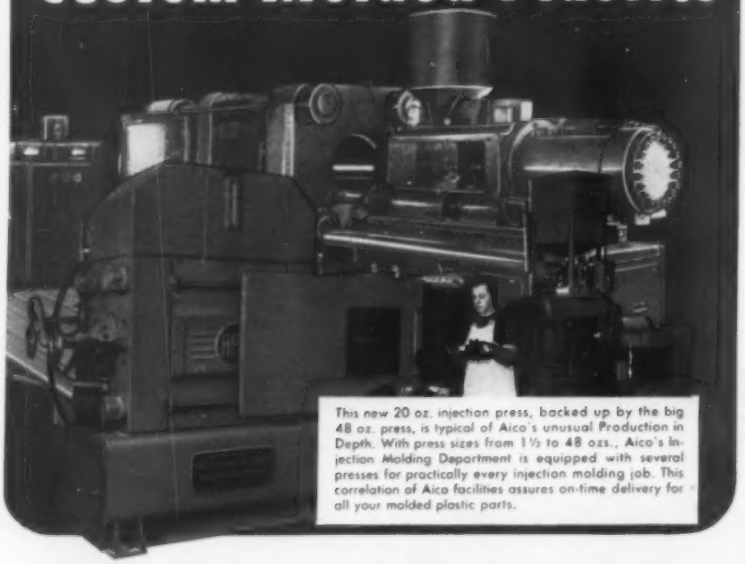

DON'T READ THIS...
if you are getting the most
out of your products
in Sales and Profits!
Aquafilter
TEL. MUrdock 8-7600
Pyro PLASTICS CORPORATION
88 PYRO PARK, UNION, NEW JERSEY
Gentlemen:
As the manufacturer, you are in the best position to know that your product is an example of good quality craftsmanship and materials. However, we would like to suggest the possibility that your product can be improved and your production costs reduced through the use of Pyro services.
Pyro's reputation is well known in the field of Thermoplastics for creative designing, practical engineering, expert molding, efficient production and on-time delivery of plastic parts or products to both standard and custom specifications . . in quantity.
We would also welcome an opportunity of "rolling up our sleeves" and working with you during the critical initial design stage of your products. There's no obligation, and you will learn exactly how Pyro can help you produce better products at lower cost.
Very truly yours,
Paul H. Schaaf, Jr.
Paul H. Schaaf, Jr.
Industrial Sales
P.S. We'll be glad to give you case histories of the items pictured here plus other efforts for firms comparable to yours.
RONSON
THE NATION'S CHOICE IN MOLDED PLASTICS
PYRO
CRADLE
SYMPHONY
TEXCEL

AICO . . . SUPER MARKET FOR MOLDED PLASTIC PARTS

Production in Depth

Assures On-Time Delivery of Your

Custom Molded Plastics



This new 20 oz. injection press, backed up by the big 48 oz. press, is typical of Aico's unusual Production in Depth. With press sizes from 1½ to 48 ozs., Aico's Injection Molding Department is equipped with several presses for practically every injection molding job. This correlation of Aico facilities assures on-time delivery for all your molded plastic parts.

At AICO, under one roof, you will find complete facilities for the economical and on-schedule production of all your custom molded plastics. Regardless of molding material, molding method used or quantities involved . . . production schedules are maintained by Aico's Production In Depth. At Aico, your job can be molded on more than one of the many presses in each Aico department. This is typical of Aico's complete plastics molding service that has provided many of America's leading manufacturers with product improvement, quality refinement and reduction of costs through the proper application of molded plastics.

SINCE 1916 — Many Products are Better Because of Aico Molded Plastics

AMERICAN INSULATOR

CORPORATION



SEND FOR THIS FREE SHOPPING GUIDE TO AICO'S SUPER MARKET OF MOLDED PLASTICS . . . Aico Facilities Booklet describes the equipment needed to provide a complete molding service. Serves as a valuable guide to selecting a fully-equipped molder to do all your work, and thus avoid the annoyance and waste of split responsibilities.

AMERICAN INSULATOR CORPORATION
New Freedom, Pennsylvania

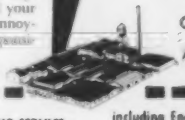
Please send me a copy of Aico Facilities Booklet describing and illustrating Aico's One-Stop Shopping Service for Molded Plastics.

Name_____

Title_____

Company_____

Address_____



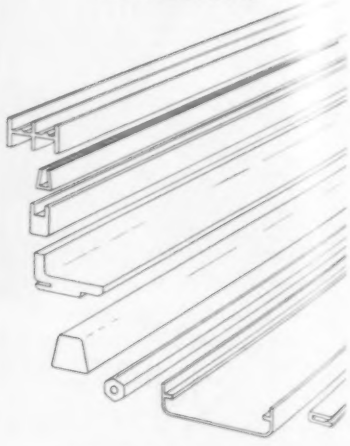
AICO'S COMPLETE PLASTICS MOLDING SERVICE: including Engineering, Mold Building, Compression, Transfer, Plunger, Injection and Cold Molding . . . Plus the molding of Reinforced Fiberglas.

SHEFFIELD PLASTICS

for Custom Engineered

RIGID PLASTIC

EXTRUSIONS



SPECIAL SHAPES, SHEETS, TUBES, RODS

made with

- Acrylic
- Acetate
- Butyrate
- Polyethylene
- Rigid Vinyl
- Regular & Impact Polystyrene

for such uses as

Fluorescent lighting diffusers & pans, molding & strapping, pen & pencil barrels, door & window channels, sliding door track, electrical components, decorative trim & edging, refrigerator breaker strips, store displays, panels, supports, hangers, housings, automobile visors.

When You Call Sheffield You Get . . .

- **PRODUCT & MATERIALS RESEARCH**
  The source of Sheffield's new and improved materials and techniques, that have made possible new products and new designs for many customers.
- **SKILLED ENGINEERING & DESIGN HELP**
  Sheffield engineers have long experience in part design, materials selection. Their knowledge helps minimize your parts cost, improve product quality.
- **PRECISION TOLERANCES**
  Experienced extrusion operators and Sheffield quality control make possible the production of rigid extrusions to meet your most exacting specifications.
- **PROMPT DELIVERY**
  Sheffield is one of the largest custom extruders, yet our operation is highly flexible — to meet any sudden or unusual customer demands.

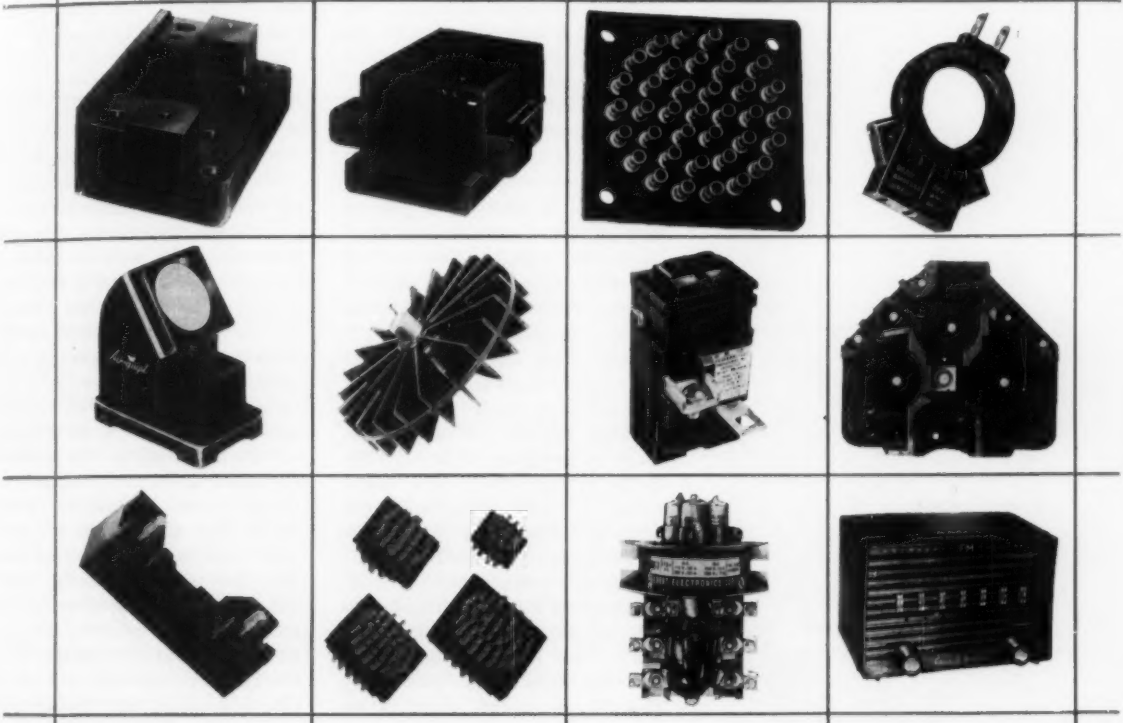
WRITE FOR COMPLETE DETAILS

to Sheffield Plastics Inc., Section 74-48 Sheffield, Mass.

SHEFFIELD PLASTICS INC.
SHEFFIELD, MASS.

CUSTOM COMPRESSION MOLDING

. . . . . our first product is Quality



Shown above are several different parts molded by KUHN and JACOB.

It's our job to custom-mold plastic parts of the highest quality that exactly fit their functional requirements. Every job, whether we start from scratch or follow customers' prints, goes through our engineering department. It is here that Kuhn and Jacob combines the benefits of many years of practical tool and die making with technical knowledge . . . often suggesting a change in design that may mean better performance in service, lower cost, faster delivery or other advantages to the customer. Not only in the plans stage and at the drafting board but through each succeeding manufacturing operation, Kuhn and Jacob engineers assume the responsibility for meeting customers' specifications—and for insuring the high quality and fine appearance of the finished piece.

Write for your copy of our catalog, "A Service to Users of Compression Molded Plastics"

DESIGNING • MOLD MAKING • CUSTOM MOLDING

KUHN & JACOB MOLDING & TOOL CO.

1200 SOUTHARD . . . . TRENTON 8, N. J.

Engineering and Methods

Injection Molding

IN THIS SECTION

Acrylics 656
Cellulosics 658
Polytrifluorochloroethylene . 661
Nylon 662
Branched Polyethylenes 666
Linear Polyethylenes 669
Polystyrene 671
Special Styrenes 672
Vinyls 678

Injection molding is a process that converts small pellets of thermoplastic resins, called molding powders, into shaped articles ranging in weight from 0.0002-oz. washers to 15-lb. battery cases.

Since most injection machines are made to work with molds that part along a single plane when opening, the articles to be made must be designed to be conveniently ejected from such molds. However, more complex shapes with undercuts, side projections, etc., have been molded by designing special molds with multi-surface parting and automatically retracting plugs. Metal inserts that are not too large can be molded into the article by positioning them in the empty mold cavity before injecting the plastic.

Basically, the process consists of five steps: 1) feeding the molding powder; 2) melting the feed; 3) injecting the melt into the relatively cool mold; 4) chilling the molding sufficiently below its softening range so that it will hold its shape when ejected; and 5) ejecting the piece. On some jobs, this process is supplemented by preheating of the feed and/or annealing of the ejected pieces.

General operation

Figure 1, p. 652, is a sketch of the longitudinal cross-section of an injection molding machine. The pellets — usually cubes, spheres, or stubby cylinders— drop from the hopper into the injection cylinder when the ram is retracted, filling the empty space. On the injection stroke the ram comes forward rapidly, forcing the pellets into the heated part of the cylinder and compacting them around the torpedo, or spreader. Fins along the torpedo keep it centered in the cylinder and conduct heat to it from the electrically heated cylinder wall. In this manner, a thin layer of the particles is heated by both the torpedo and the cylinder. In some machines, separate cartridge heaters are installed in the torpedo. Each successive stroke of the ram forces them further left until finally the material in the melt zone is forced out of the cylinder into the mold. Normally, there will be several cavities in the mold; the melt entering the center of the mold through the sprue reaches the cavities via small channels called runners. The part of the runner immediately adjacent to the mold is called the gate. Usually, this gate will have a much smaller cross-section than the runner, but there are cases where they may be about the same size, or, as with the acrylics, may sometimes be even larger than the runner. The melt in the cavities loses heat to the cold metal of the mold and freezes, starting at the outside surfaces. When a sufficient thickness has frozen, the mold opens and ejector, or knockout, pins poke the pieces out of the cavities. The mold is closed and the entire cycle is repeated. Although some molding machines are referred to as continuous, the process is clearly an intermittent rather than a continuous one. Equilibrium in the usual engineering sense is never achieved anywhere in the machine. This intermittency, of course, serves to complicate the

detailed analysis of what is happening to the material inside the machine.

Although the injection molding process ends with ejection of the piece from the filled mold, understanding begins there. We are accustomed to thinking of gases as being compressible, liquids and nonporous solids as incompressible. Plastics melts, however, probably because of their spongy molecular structure, exhibit considerable compressibility and have large coefficients of thermal expansion. Under the large changes in pressure and temperature encountered in injection molding, these characteristics result in considerable changes in density. The equation-of-state concept, so successful with gases, also works with plastics melts (40).[1] The fundamental notion is this: the density of a nonmoving plastics melt is fixed by its pressure and temperature. With some modification, the idea is also valid for plastics in the solid phase; the usual recognition of the effects of phase changes must be made, and, because some plastics may reach equilibrium density rather slowly at low temperatures, the rate of cooling or heating may be a significant factor.

The densities of most plastics at room temperature and one atmosphere pressure are highly reproducible, and it is known that, given a little time, a molded plastics object will return after molding to this density, known as the "standard density." If the equation relating density to pressure and temperature is known, it is simple to calculate what the weight of a piece made in a mold of given volume will be. From this weight and the standard density, its volume at room temperature and its approximate dimensions can be calculated. Thus, the equation-of-state is a tool for estimating molding shrinkage and calculating the effects on piece dimensions of changes in molding conditions. The idea, along with some data and calculations, is discussed at length in Reference 39. Here we can sum it up by noting that density increases as pressure is increased or as temperature is decreased, the temperature effect being much the larger. Thus, raising the injection pressure results in cramming more matter into the mold cavity (this is *not* due to stretching of the cavity—since it is usually made of thick, stiff steel, that stretches negligibly at the pressures involved); when this heavier piece is ejected from the mold at atmospheric pressure, it decompresses to a larger volume than would a piece molded at a lower pressure. Similarly, the higher the molding temperature, the greater the subsequent contraction when the piece is chilled to room temperature. This basic behavior pattern explains why melt pressure at the nozzle must be closely controlled if close dimensional tolerances are to be held on the plastics pieces which are to be molded.

[1] Numbers in parentheses link with References on p. 655.

Feeding

The direct feeding method shown in Fig. 1, p. 652, where the plastic pellets fall directly from the hopper into the heating cylinder, depends for its regularity on the fact that the ram retracts to the same point before each feed stroke. Presumably, then, the same volume is refilled on each cycle, giving rise to the term "volumetric feeding." In practice, however, the method has resulted in variations in shot weight and piece dimensions, and in flash on large-area pieces. Flash occurs when the mold opens slightly and some melt "flashes" into the parting crack, leaving an unwanted fringe around the piece. These variations can be traced to variations in pressure at the nozzle, which in turn are due mostly to variations in the weight of material fed. (19). Because the orientation of loosely falling cubes is not the same from shot to shot, the *weight* fed by the "volumetric" method can vary over a wide range, particularly in the smaller machines. An extra-heavy shot results, on the next shot, in there being a thicker-than-usual bed of solid particles through which the ram pressure must be transmitted to the melt. Since the ram pressure is set at a fixed value, the pressure at the nozzle drops, causing "short shots" (cavities only partly filled) or reduced weight and dimensions even when the cavity appears to be filled.

Improved regularity of feeding is accomplished by two methods, the weigh-feeder and the vibratory feeder. A weigh-feeder, as its name indicates, weighs the shot out from a secondary hopper and drops it into the injection cylinder. In reasonably sized shots, say 2 oz. and up, the precision of feeding depends only on the precision of the scale, and excellent scales have been adapted to this purpose. The vibratory feeder consists of a hopper supplying a magnetically vibrated trough, and a timer that regulates the interval of vibration. With cubes, in particular, precision is good—on the order of $\pm$ 1 percent.

Precision feeding does not completely solve the problem of shot-to-shot uniformity of pressure at the nozzle, since the unmelted particles in the cylinder cannot be relied upon to pack in the same way on each stroke. Bridging of the solid particles is especially important when the machine is operating close to its plasticating capacity, i.e., the maximum rate at which it can produce melted plastic, because in this condition there is a large volume of unmelted solids in the cylinder.

Recently a more direct approach to getting uniform nozzle pressures has been introduced. It consists simply of measuring the nozzle pressure and using the measurement to control the ram pressure. Variations due to irregular feed or bridging in the cylinder are thus compensated by changes in ram pressure.[2] This method should find increasing acceptance among molders who must meet close dimensional tolerances on their output.

A third method of reducing shot-to-shot variability in moldings is to have no solids at all in the injection cylinder. Instead, melting is accomplished in an auxiliary chamber called a preplasticator and the melt is transferred to the injection cylinder before the injection stroke. This guarantees as good uniformity of

[2] Two different devices for controlling nozzle pressure were offered to the public during 1956, but only one has been adapted to all makes of molding machines. It is available from West Instrument Corp., Chicago, Ill.

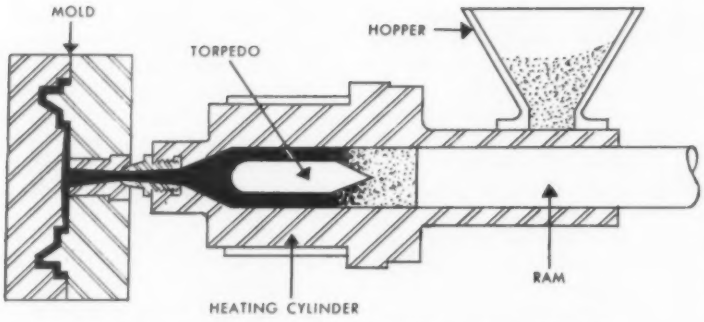


Fig. 1: Longitudinal cross-section of injection molding machine. Pellets of resin feeding from hopper are melted in the heating cylinder and forced forward by the ram into the mold where the melt is cooled and solidified

pressure at the nozzle as can be achieved in the hydraulic system driving the ram. Preplastication will be further discussed below.

Melting the feed

An injection machine is usually rated by the amount of general-purpose polystyrene it can deliver in a single shot. An equally important criterion is the plasticating capacity of the machine (31, 33). Although no standard has been set up to measure this capacity, it can loosely be thought of as the number of pounds per hour of cold molding powder that the heating cylinder is capable of melting. Obviously, this will be different for different resins and will depend on the melt temperature desired. Since higher temperatures are required for filling thin, large-area sections than thick, blocky ones, the plasticating capacity, in a practical sense, will depend on the job being done. However, it also depends on the design of the heating cylinder (27, 18, 16, 12, 13). All plastics are poor conductors of heat; yet even in the melt phase, because they are so viscous, they must be heated by conduction rather than convection or radiation. (Even in sheet forming, where radiant heat sources are used to heat the sheets, the heat is *conducted* into the interior.) It is therefore essential, for fast heating, to use the highest possible temperature gradients and the thinnest possible layers of plastic. Unfortunately, heating temperatures are severely limited by the rate of decomposition of the plastic. Even small percentages of decomposed resin may seriously impair strength, toughness, color, and surface finish of the pieces. In the melt zone of the cylinder, some material is in actual contact with the cylinder wall and because of the layer-like nature of viscous flow, material close to the wall moves very slowly. *Thus, if the wall temperature is above that level at which the material is decomposed significantly in a 20-min. interval, the molded product will inevitably contain a certain percentage of inferior material.* Because it is so easy to boost cylinder temperatures when increased plasticating capacity is needed, this unpalatable fact was accepted by molders only after it was decisively proved by molding many defective pieces.

The trend of heating cylinder design, therefore, has been directed at: 1) increasing the area of contact between plastic and metal, and 2) reducing the thickness of the heated layer. Both these aims have led to larger cylinders and larger torpedoes with reduced space between the two. One maker of replacement cylinders[3] has achieved multiple increases in heating capacity with reduced thermal hazard by abandoning the torpedo concept entirely. His cylinders are simply solid hunks of steel with many longitudinal circular holes drilled in them (16). Since the steel temperature is almost uniform throughout the block, heat pours into the plastic from all of the cylindrical surfaces of the holes.

Relatively recently, (12, 13) two similar designs were introduced. In both of these the standard torpedo is replaced by a perforated, grooved insert. The plastic pellets are forced against its inside surface and are partly melted until they can enter the perforations. Melting continues as they pass through the holes and grooves. On the stroke of the ram, the newly melted layer is skimmed off and forced out the nozzle and into the mold, while new pellets are forced against the liner surface. Advantages claimed for these designs are: greater plasticating rates, more uniform melt temperature, reduced thermal hazard, and better transmission of ram pressure.

Most cylinders are heated by band heaters wrapped around their outside surface. Because the added bulk of insulation is objectionable, most of these heaters are exposed to the air or covered with very thin insulation. As a result, more of their heat is lost to the surroundings than goes into the plastic. Future cylinder designs will probably tend toward more efficient use of heat.

The plasticating capacity of a given heating cylinder can be estimated from its dimensions and the thermal properties of the plastic to be molded. Some data on such properties are available from material suppliers.

The equations of heat conduction, integrated for heating long slabs or rods, may be used. Handy solutions of these equations were presented in graphical form by Gurney and Lurie (41) and they are reproduced in many books dealing with heat transmission (39a).

Pressure drop in the cylinder may be estimated from a formula presented in Reference 38. A recent extension of this work to include the effects of lubricants was reported in 1956 (10).

Injection

During the injection stroke the melt is forced at high rates of flow through the nozzle, sprue, runners, and gates into the mold cavities. While the problem of computing flow rates of hot melts under molding machine conditions is still under consideration, much has been learned about their flow

[3] Injection Molders Supply Co., Cleveland, Ohio.

behavior in the laboratory (23, for example). This knowledge serves as a guide in designing runners and gates. For example, it is known that polymer melts are non-Newtonian, i.e., they do not obey Newton's law that says flow is proportional to pressure drop. Rather, their flow is proportional to the second or higher power of the pressure difference. This means that, if the pressure available at the nozzle varies 5% from shot to shot, the filling rates will vary by 10 to 20 percent. This in turn will cause variations in the amounts of material injected, the piece weights, and their dimensions. Similarly, if the runner design and layout is such that higher pressures are available at some gates than others, the cavities served by the low-pressure gates will deliver smaller pieces than those that are getting the higher pressures. They will also fill more slowly, may be weaker because of more severe frozen-in stresses, and sometimes do not even fill completely before the gate freezes off. For these reasons it is important, when close control of dimensions and properties is needed, to design gates and runners according to the principle of "successive simultaneity." This principle may be stated thus: the melt should reach all the gates at the same instant, the filling of all the cavities should be completed at the same instant, and the gates should seal at the same instant. The design of runner systems according to this principle was discussed in Reference 9 for the very common case where all the cavities are alike. Figure 2, p. 655, is a diagram of a layout for a 16-cavity mold that achieves successive simultaneity.

Considerable attention has been given in recent years to the speed of filling the mold (22, 11, 8). It is desirable, from the standpoint of avoiding thermal decomposition and shortening the time required for the piece to set up in the mold, to use a low melt temperature. However, as temperature drops, pieces freeze more quickly (as desired) and the cavities must be filled more quickly if they are to be filled at all. This requires faster rates of injection. Another important advantage of fast filling is this: the cavity is completely filled before viscosity has increased to the point where stresses connected with flow rise to a high level, and what stresses do arise have more time to "relax" before the melt freezes.

A characteristic of plastics is their viscoelasticity, or delayed elasticity. When they are subjected to stress—as they are during melt flow—a definite time elapses before the rate of flow reaches a maximum and becomes steady. Similarly, when flow ceases, a definite time is required before the stress decays to zero, i.e., relaxes. Unfortunately, these stresses increase with increasing viscosity at a given flow rate, and at temperatures just above the freezing point may be very large, approaching the strength of the plastic. Relaxation time also increases as the temperature drops. Thus, it is likely that if the mold is filled too slowly, parts of the melt will have frozen while in motion, and the severe stresses, unable to relax, will be frozen in. The effective strength in those parts of the piece will be reduced by the amount of frozen-in stress. Molded-in stresses in polystyrene have been investigated and reported on in References 37, 36, 34, 23, 22, 21, 15, and 11.

The realization that fast filling can reduce cycle time and improve quality—thus improving productivity in two ways—has resulted in "souping up" of injection machines until today the new machines have much higher pumping capacity at injection pressure than they used to have only five years ago.

Filling rate cannot be increased indefinitely without "burning" the melt. The great resistance that these materials offer to flow means that much work, per pound of material shot, must be done to get it from the nozzle into the cavity (26). This work appears as heat in the plastic. Where restricted gates are used, the usual case, much of the whole pressure drop occurs across the gate and its temperature may rise by 30° F. or more as it goes through the gate.

Aside from the effect of sudden viscous working, the melt may be burned even more severely if the rapidly filling cavity is not adequately vented. If the air that fills the cavity at the start of injection cannot escape rapidly enough it may be compressed to a tiny fraction of its original volume, and tremendous heat of compression is developed. The plastic in contact with this compressed air takes fire much as does diesel fuel injected into an engine cylinder under compression, and it is severely charred. Most molds can be satisfactorily vented by making some small scratches in the mold faces from the cavities to the outside of the mold. Venting may also be accomplished by leaving a small clearance around the ejection pin. With some shapes, however, unfortunate combinations of knockout-pin location and gate location result in air trapped in regions away from the parting line or the pins. Vacuum venting (7) is recommended for these cases and offers many advantages.

Ejection

With simple solid shapes, ejection is usually accomplished by having a metal finger, e.g., an ejection or knockout pin, poke out of the cavity surface as the mold opens, forcing the piece from the cavity. To be knocked out without being deeply marked, the freshly molded piece must have been chilled (e.g., "set" or "cured") to a temperature at which it has sufficient hardness. It must also have become stiff enough to hold its shape after it is deprived of the support of the mold.

Ejection of deep-draw shapes, (drinking tumblers, bushings, containers) is made much simpler and more reliable if the ingoing sides of the piece are slightly tapered, or given "draft." When no draft can be allowed—as is usual with bushings, gears, spools, and other machine parts—a knockout sleeve may be used in place of pins. The sleeve can apply a much larger knockout force than a pin without mutilating the piece because the force is distributed over the whole of the piece end and over a larger area. Ejection is also aided by materials known as mold releases. A typical release is any of several Freon-propelled silicone oils, and it is typically

sprayed on the mold surfaces when the mold is open, every few shots. Most silicone releases leave an oily film on the surfaces of the part and are objectionable if the part is to be printed, painted, or metalized after molding. Polymeric and wax-based releases are available.

In highly polished molds, the molded piece and the mold face may cling together as gage blocks do. An attempt to separate them by direct pull creates a partial vacuum and air pressure stubbornly holds them together. In such cases a fast jet of air directed at the edges of the piece facilitates ejection.

Mold design

Only a few vital points on mold design can be discussed here, since, in detail, this topic could fill a book the size of this one. The first is uniformity of temperature from cavity to cavity. The flow of melts is very strongly affected by changes in temperature, as has already been noted. If there are significant variations in temperature over the face of the mold (5° F. will often be too big a difference), the melt passing through the colder runners will flow more slowly, reach the gates late, fill more slowly and probably less, and freeze sooner. The results are cavity-to-cavity variations in dimensions and strength properties. From the standpoint of uniformity of product quality, *very uniform mold temperatures are a must* in multi-cavity molds. Temperature should of course not vary from shot to shot, even in single-cavity molds, for the same reasons. Getting this uniformity of temperature requires careful attention to the laying-out of the cooling channels in the mold and requires also an adequate supply of the cooling medium.

The second point, runner layout, has already been covered on p. 653.

A third important consideration is the projected area. The product of this area times the pressure in the mold, which may be as much as 80% of the ram pressure, must be well within the clamping capacity of the machine. In addition, the mold itself must be stiff enough so that it will not spring open under the hydrostatic separating force. If, for example, a long thin piece of sizable area is molded in the center of the mold, flash and erratic dimensions may be a problem unless the mold is given extra support at the center.

Fourth, for ejection's sake, some draft should be provided wherever possible in deep-cavity molds. Good mold design depends heavily on good piece design. Sharp corners, intricate outlines, draftless holes, etc., all tend to make molding more difficult and therefore more expensive.

Fifth, there should be a constant interchange of ideas among the product designer, mold maker, and molder for best results. Unnecessarily high tolerances increase mold costs; too loose tolerances on runners and gates can result in a high reject rate.

Sixth, the smallest possible gates consistent with good piece quality and complete filling of the cavities are usually specified, for this reason: when the frozen pieces are ejected, the runners must be separated from them; the smaller the gate, the easier is this separation. If the gate is small enough the runner can simply be broken off without marring the piece. Thus, small gates both facilitate operation, particularly automatic operation, and reduce finishing costs. Also, too-restricted gates are easily opened, whereas too-open gates are very difficult to close.

Last, when production runs are long, money spent on building tools helps later to reduce maintenance and down time. Some types of short-run tooling are discussed in the section on Plastics Tooling, p. 743. Metal-loaded epoxy tooling is discussed in Reference 14, p. 655.

Front and rear views of radio cabinet injection molded from polystyrene. Gating is designed to provide even fill of sharp-cornered sections containing several thick bosses. (Photo, National Automatic Tool)



Predrying of powder

Some plastics are hygroscopic, i.e., they extract water from the surrounding air and get wet. If they are molded in the wet condition, many troubles arise. The moisture cannot easily escape and may cause foaming at the nozzle during the mold-open time. Even slight foaming will cause smeared-out foam, or "splay," to appear on the surfaces of the pieces. Severe reductions of physical properties may occur as a result of water-caused degradation.

If the feed is predried, the drying is commonly accomplished by exposing the powder to circulating hot air (see Reference 2 for a discussion of the current status of this procedure). Since the powder is heated to about 180° F., if it is fed immediately, the injection machine is relieved of a substantial fraction of its heating load. Thus predrying, *alias* preheating, is an indirect way of increasing the plasticating capacity of an injection machine.

Annealing

As was noted above, molded parts sometimes suffer serious reductions in strength because of molded-in stresses. Conditions may be such that these stresses cannot be prevented during molding. If such parts are held at an elevated temperature for the proper time, these internal stresses will eventually relax (37, 36, 23, 15). The temperatures must not be too high, else they will warp or "stubbify" the resoftened part. The usual methods are to immerse the piece in a bath of hot liquid (water is common), or to keep it in a circulating-air oven for a while, the time depending on the material, temperature, the part shape, and the molding conditions. The annealing of some

materials is discussed in the individual articles on specific materials.

Preplastication

Preplastication is the technique, involving extra equipment, whereby the molding powder is melted in one chamber then transferred to the injection chamber before injection. Usually, the melting chamber is a cylinder much like the injection cylinder, though variations exist. Originally, preplasticators were developed to increase the shot capacity of the extra-large machines; the largest on record is rated for over 55 pounds. More recently, other advantages have become apparent (19, 8). Briefly they are: increased productivity because of faster cycles and reduced reject rates. Since there is no bed of recalcitrant particles in the injection cylinder, much lower ram pressures can be used, and much better control of injection pressure is attained. Because some mixing is accomplished as the melt is transferred from the melting chamber to the injection cylinder, melt temperature is more uniform. Very high injection rates are possible.

Mold temperature

In the paragraphs on Mold Design, above, the importance of mold temperature uniformity was discussed. Shot-to-shot uniformity, of course, requires not only shrewd coring, but also close control of the cooling medium temperature. This medium is nearly always water, but oil and steam have been used. On very small machines, molds may be electrically heated and air cooled.

It has been recognized that moldings harden faster in colder molds. Where flow properties permit, then, we should expect that the cycle could be shortened by lowering the mold temperature. Many molders are using refrigerating equipment of a compact, portable type to chill the water that circulates through the mold. Aside from keeping the mold colder, the technique provides close regulation of water temperature. It incidentally cuts the water consumption to almost nothing, an important consideration in dry areas. To avoid surface defects, the temperature of the mold faces must be above the dew-point of the air in contact with them. The effects of mold temperature on the flow of polyethylene and on the properties of molded polyethylene pieces have been investigated rather thoroughly (6). In brief: lowering the mold temperature increases strength and stiffness, improves clarity, slightly reduces surface gloss, and reduces cycle time substantially.

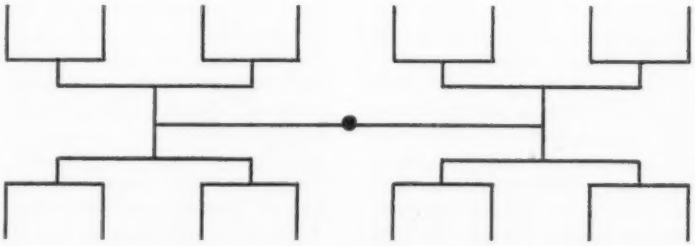


Fig. 2: Runner layout for a 16-cavity mold is designed so that melt reaches the gates at the same instant, filling of the cavities is completed at the same instant, and gates all seal at the same instant. All cavities are alike

The chapters directly following this one provide more detailed and specific information on the injection molding of the various thermoplastics.

References

Some of the following references were cited by number as giving more detail on certain points discussed in this chapter. Others, though not cited, are useful in learning what goes on in injection machines during the various phases of the molding process. All contain information applicable to the injection molding of most thermoplastics, though work reported in some of them has been restricted to a single material. The list is not exhaustive, and nothing on molding that appeared before 1949 is listed. Little of value, from the fundamental standpoint, appeared before that year. The breakthrough of the scientific approach to injection molding occurred in Reference 39, in 1950, and in other papers by the authors and their associates.

1. Griffiths, L., "Spiral-flow molding," MODERN PLASTICS *34*, 111, Aug. 1957.

2. McCosh, F. I., "Predrying of molding powders," MODERN PLASTICS *34*, 120, Aug. 1957.

3. Farris, R. N. and Meeks, P. J., "Importance of mold rigidity in injection molding," Plastics Tech. *3*, 371, May 1957.

4. Reilly, F. J., Hill, V., and Jones, D. A., "The effect of gating on molding linear polyethylene," SPE J. *13*, 28, April 1957.

5. Maxwell, B. and Matsuoka, S., "Bulk compressibility of polymers at fabricating temperatures," SPE J. *13*, 27, Feb. 1957.

6. Imig, C. S., "Mold temperature effects in polyethylene molding," MODERN PLASTICS *34*, 149, Dec. 1956.

7. Bohannon, G. S., "Vacuum venting of molds," MODERN PLASTICS *34*, 162, Dec. 1956.

8. Schwartz, H. H., "Preplasticators pay off on small shots, too!" MODERN PLASTICS *34*, 143, Nov. 1956.

9. "Runner and gate design," MODERN PLASTICS *34*, 166, Oct. 1956.

10. Toor, H. L. and Eagleton, S. D., "Plug flow and lubrication of polymer particles," Ind. Eng. Chem. *84*, 1825, Oct. 1956.

11. Horsley, R. A. and Lee, D. J. A., "The influence of flow orientation and injection temperature on the strength of injection moldings," Brit. Plastics *29*, 134, April 1956.

12. Bernhardt, E. C. and Paggi, L., "Polyliner improves injection molding," MODERN PLASTICS *33*, 109, Feb. 1956.

13. Maccaferri, M. and McKee, R. B., "The Maccaferri injection molding heating chamber," SPE J. *12*, 11, Feb. 1956. Discussion appeared in SPE J. *12*, 55, May, 1956.

14. Creighton, Jr., A. M., "Low-cost molds for short runs," MOD-

ERN PLASTICS *33*, 121, Nov. 1955.

15. Ziegler, E. E. and Brown, W. E., "Stress cracking (crazing) of polystyrene I and II. I: P astics Tech. *1*, 341, July 1955, II: Plastics Tech. *1*, 409, Aug. 1955.

16. Morse, A. R., "Effects of thermocouple location and wattage control on injection cylinder temperature," Plastics Tech. *1*, 277, June 1955.

17. Moslo, E. P., "Runnerless injection molding," MODERN PLASTICS *32*, 119, April 1955.

18. Beyer, C. E., Dahl, R. B., and McKee, R. B., "Temperature and pressure measurements in the injection machine heating cylinder," MODERN PLASTICS *32*, 127, April 1955, MODERN PLASTICS *32*, 110, May 1955, MODERN PLASTICS *32*, 127, June 1955.

19. Thayer, G. B., "Precision control of injection molding pressure," Plastics Tech. *1*, 91, Mar. 1955.

20. Griffiths, L., "Temperature control in injection moulding," Brit. Plastics *27*, 134, April 1954.

21. Gasper, E., "A study of the problems involved in high-quality injection moulding," Plastics Prog., 1953, Iliffe & Sons, Stamford St., London S. E. 1, Eng.

22. Schmidt, P. E., "Injection speed (is of special importance in production of large-area, thin molded pieces)," MODERN PLASTICS *31*, 119, Nov. 1953.

23. Melchore, J. A. and Mark, H. F., "Effect of strains on heat distortion," MODERN PLASTICS *31*, 141, Nov. 1953.

24. Bostwick, R. and Jos'in, C. A., "Restricted gating," MODERN PLASTICS *31*, 125, Oct. 1953.

25. Whitlock, C. H., "Mold temperature control," MODERN PLASTICS *31*, 131, Oct. 1953.

26. Toor, H. L., and Eagleton, S. D., "Energy conversions in the flow of high polymers: applications to injection molding," J. Appl. Chem. *3*, 354, Aug. 1953.

27. Gilmore, G. D. and Thayer, G. S., "Some design considerations for injection molding heating chambers," Trans. A.S.M.E. *75*, 903, July 1953, ab: MODERN PLASTICS *31*, 142, Dec. 1953.

28. Tordella, J. P., "Melt extrusion of polyethylene," SPE J. *6*, 9, May 1953.

29. Towsley, F. E. and Beyer, C. E., "Pressure gage for injection molding," MODERN PLASTICS *30*, 109, Mar. 1953.

30. Beyer, C. E. and Dahl, R. B., "Basic principles of injection molding," MODERN PLASTICS *30*, 103, Mar. 1953.

31. Beyer, C. E. and Dahl, R. B., "Measurement of heating capacities of injection molding machines," MODERN PLASTICS *30*, 124, Sept. 1952.

32. "Hot runner molds," MODERN PLASTICS *29*, 101, June 1952.

33. Sloane, D. J., "A proposal for establishing certified injection molding machine specifications," SPE J. *8*, 7, Jan. 1952.

34. Gaspar, E., "Basic features influencing the performance of injection molding machines," Plastics Prog., 1951, Iliffe & Sons.

35. Gilmore, G. D. and Spencer, R. S., "Photographic study of the polymer cycle in injection molding," MODERN PLASTICS *28*, 117, April 1951.

36. Spencer, R. S. and Gilmore, G. D., "Residual strains in injection molded polystyrene," MODERN PLASTICS *28*, 97, Dec. 1950.

37. Dunlap, R., Pokigo, F., and Glick, S., "Annealing injection-molded styrene," MODERN PLASTICS *27*, 83, Aug. 1950.

38. Spencer, R. S., Gilmore, G. D., and Wiley, R. M., "Behavior of granulated polymers under pressure," J. App. Physics *21*, 527, 1950.

39. Gilmore, G. D. and Spencer, R. S., "Role of pressure, temperature, and time in the injection molding process," MODERN PLASTICS *27*, 143, April 1950.

39a. Perry, J. H., (ed.), Chemical Engineers' Handbook, 3rd Ed., p. 462, McGraw-Hill Book Co., New York, 1950.

40. Spencer, R. S. and Gilmore, G. D., "Equation of state for polystyrene," J. App. Physics *20*, 502, June 1949.

41. Gurney and Lurie, Ind. Eng. Chem. *15*, 1170, 1923.

INJECTION MOLDING ACRYLICS

BY G. G. FREYGANG*

Acrylics are used primarily in those applications where their outstanding properties of optical clarity, outdoor stability, chemical resistance, and dimensional stability are of importance. It is, therefore, important that the handling and molding of these materials be consistent with these attributes.

Handling

The acrylics are not compatible with other plastics, and such mixtures will destroy the clarity of the molded parts. In similar manner, the three acrylic grades cannot be mixed without producing objectionable distortion.

Dirt, lint, and dust will detract from the clarity of the molded parts. Good handling practices are therefore of extreme importance. Because of the inherent tendency of practically all plastics to develop static charges, it is virtually impossible to prevent dust accumulation on reground material, even under ideal conditions. It is usually more desirable to use screened reground material in less critical parts than to blend it into virgin material with the possibility of degrading the entire mixture.

Molding characteristics

See Table I, p. 657.

Annealing: It has been established that the most stress-free molding (1)[1] will give the best service with respect to dimensional stability at elevated service temperatures, resistance to chemical attack, and long time outdoor exposure. Molding at moderate-to-high material temperatures, with adequate but not excessive pressure into warm and carefully controlled molds will produce the most stress-free parts (2). Annealing will tend to redistribute and lower the inherent molding stress and will produce superior parts. Annealing is imperative if the parts are to be decorated by painting or lacquering. In no case, however, should annealing be considered as a means to overcome poor molding practices.

Mold design: Well-designed

* Development Engineer, Plastics Laboratory, Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.

[1] Numbers in parentheses link to Special References on p. 658.

molds are an important adjunct to the production of well-molded parts. Adequate sprue, runners, and gates are necessary. For many parts, an 11/32-in sprue bushing, matched to a 9/32-in. nozzle, is satisfactory. Runners should preferably be full round, 5/16 in. in diameter if less than 10 in. in length, 3/8 in. in diameter if longer. Suggested gate sizes are listed in Table I, below. In multiple-cavity molds, balanced runner length, balanced gates, and balanced venting, if required, are all necessary if uniform fill patterns are to be maintained (3). Good mold design also provides adequate draft for easy release and sufficient knock-out points so that the parts are not stressed due to ejection. Properly designed molds seldom, if ever, require the direct application of mold release agents.

Predrying: Predrying of acrylics is recommended. Because of the inherent tendency to absorb some moisture, the acrylic molding powder may have varying amounts of moisture at the time of use, in spite of the care taken in its preparation and packaging. If the moisture content is high, molding conditions may have to be modified to suppress defects due to this moisture. The usual remedies are lower material temperature and higher pressure, both of which will cause more highly stressed, and thus less serviceable parts. Predrying also contributes toward a more uniform feed temperature, particularly if hopper dryers are used. The uniform feed temperature in turn contributes to more uniformity in material temperature and pressure.

Hopper driers and ovens can be used. In the hopper drier, 3 hr. at 180 to 200° F. is recommended; in ovens, 2 hr. at 180 to 200° F. is recommended.

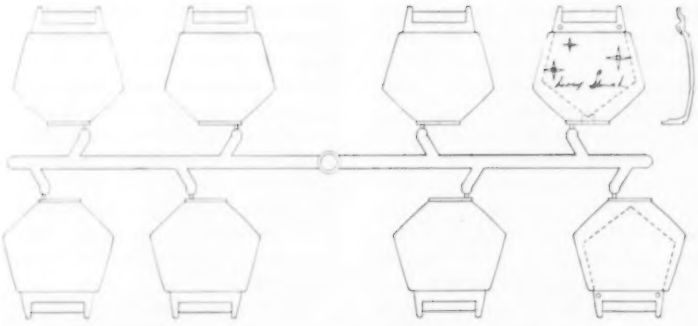
Machine capacity: The selec-

TABLE I: Injection molding characteristics of acrylic molding powder*

(Recommended molding conditions for various section thicknesses)

Thickness of section:	*less than 1/8 in.*	*1/8 to 1/4 in.*	*over 1/4 in.*
A. Temperatures, °F			
1) rear cylinder	480-500	480-500	480-500
2) mid cylinder	440-450	440-450	440-450
3) forward cylinder	440-450	440-450	440-450
4) nozzle	375-390	375-390	375-390
5) mold face	175-190	175-190	175-190
6) melt leaving nozzle	400-420	400-420	400-420
B. Pressure exerted on material by ram, p.s.i.			
1) in standard cylinder	15,000	20,000	20,000
2) in injection cylinder of preplasticating machine	3-5000	3-5000	3-5000
C. Timing			
1) total cycle (including mold-open time), sec.	35-40	40-60	60 per 1/4 in.
2) ram forward time, sec.	10-15	15-25	30 and up
D. Recommended gate dimensions (assuming cavity volumes of 1, 4, and 16 cu. in. for the three section-thickness classes)			
If round, diameter, mils	75	120	187
land length, mils	70	70	70
If rectangular, depth, mils	75-90% of wall	75-90% of wall	75-90% of wall
width, mils	1½-2 × depth	1½-2 × depth	1½-2 × depth
land length, mils	70-80	70-80	70-80
E. Annealing			
1) medium	Hot-air circulated oven		
2) temperature, °F	170	180	190
3) time, min.	120	120	120-240
F. Shrinkage allowance, mils/in.	Without annealing	Without annealing	Without annealing
1) in direction of flow	4	4	5
2) perpendicular to flow	3	3	4

* Based on Grade 8 acrylic molding power.



For injection molding acrylic shaver housing, a "delta-wing" runner pattern as shown here can be used for the tab-gated multiple-cavity mold. The pattern aids in the even filling of secondary runners. (Diagram, Rohm & Haas)

tion of machine size will have an influence on the quality and yield of molded parts. Normally, the best results are attained if the shot weight is no more than 75% of the machine capacity. Molding over this capacity may produce material temperature variations within the shot and lower the available pressure at the mold. Excessive over-capacity of the machine is also undesirable.

Recommended temperatures for rear cylinder, mid-cylinder, forward cylinder, nozzle, and mold face are listed in Table I, p. 657. The temperature of the melt as it leaves the nozzles is also listed in Table I.

Special References

1) A simple test for evaluating the relative stress in parts molded under different conditions is outlined in "New gating for acrylics" by J. F. Moore, SPE J. *13*, No. 3, 17, March, 1957.

2) "Service temperature characteristics of molded acrylic parts" by Gouza and Robertson, SPE J. *12*, No. 9, 19, Sept. 1956.

3) Runner and gate design," MODERN PLASTICS *34*, No. 2, 166, Oct. 1956.

INJECTION MOLDING CELLULOSICS

BY P. H. ERICKSEN*

The four types of cellulose plastics having volume usage for injection molding applications are cellulose acetate, cellulose propionate, cellulose acetate butyrate, and ethyl cellulose. Each has its distinguishing characteristics, but being of the same family they are similar in a number of ways. In particular, these plastics are noted for their toughness, dimensional stability, surface appeal, almost unlimited color range, heat stability, and ease of molding and fabrication. They are all prepared from their basic polymers into workable plastic form by compounding with proper plasticizers.

A number of different plasticizer types are used, and it is quite common to combine two or three to advantage. By virtue of the modifications which can be made in formulation, very broad ranges of physical properties and molding characteristics are possible. Through proper selection of base polymer and type and amount of plasticizer, specific property combinations can be "designed" into the plastic.

*Cellulose Products Dept., Hercules Powder Co., Inc., Parlin, N. J.

Handling

Predrying: To obtain good results in molding cellulosics, proper drying is essential, particularly since these plastics are slightly hygroscopic in nature. Presence of excessive moisture is cause for such defects in the molded piece as surface mica, blisters, and bubbles. Drying of the granules to a moisture content of 0.2% or less is recommended. This may be accomplished in the following manner:

Type of equipment: Hopper drier or circulating-air oven (tray drier)
Drying time, hr.: 2 to 6
Dry temp., °F.: 160 to 200

In hopper driers, the higher temperature levels up to 200° F. can be used if it is known that the material in use will not tend to lose its plasticizer through volatilization or become tacky and bridge across the hopper throat.

If a tray drier is used, the recommended depth of granules in the trays is about ¾ inch.

Infra-red driers can also be used. Among infra-red driers, those best suited to production use are endless-belt or vibrating-conveyor units, which in a continuous type of operation pass the granules in a thin layer under infra-red lamps for a controlled exposure.

Handling: Care in handling to avoid contamination is necessary, but no special handling conditions are required.

Equipment and molds

Equipment: No special equipment is necessary when molding the cellulosics. Certain recommendations are offered, however.

For example, a heater band for the *nozzle*, with separate Variac control, is recommended. Generally, 100 w. is adequate. The heat should be adjusted to give a slight pull-out of plastic melt on the nozzle end of the sprue.

Large-hole nozzles are also preferred for easier fill because they lessen pressure loss. The size, however, will necessarily be slightly under that of the sprue's minimum diameter.

Recommended materials of construction for *cylinders* and *spreaders* are SAE 4140 or 4340 steels.

Mold design: Identical-cavity layouts are highly preferable to "family" molds from the standpoint of balanced flow, simultaneous filling, and minimizing of flash. A flash chrome plating of cavities is recommended.

Gating: See Table I, p. 660, Section D. Dimensions listed in Table I are based on the restricted type of gate and are applicable as starting recommendations for all cavity sizes within the given limitations. Gates may

be enlarged, particularly in the large-size heavier-thickness cavities, if necessary.

Except possibly for relatively large moldings, the restricted gate has a number of advantages over the full-open type. Properly applied, it provides improved uniformity of flow-out, minimizes turbulences and resultant stresses, and enables better escape of gases from the cavity. Also, more rapid setup at the gate acts to eliminate sinks and flow-back and in turn enables a shorter piston-forward time in cycle. Another advantage is reduced trimming and finishing.

At the same time, the tendency for somewhat lower impact strength to occur near the gate area should be kept in mind. Generally, with restricted gating, it is desirable to gate into the thin cross-section end of a cavity. The plastic should enter the cavity in a direction perpendicular to the main direction of flow within the cavity and directed against an opposing wall or pin so that the center of flow is dispersed. This provides more uniform fillout and eliminates "worming."

The molding of mottles through restricted gating will result in a blending-out effect, but as the diameter approaches 0.050 in., good pattern can be obtained.

Runners: A recommended layout of cavities and runner system would feature the following: 1) equal runner distance from sprue to all cavities; 2) a balance in cavity distribution by having an equal number per runner and per branch of runners; 3) full-round runners; 4) a stepwise reduction of 1/32 in. in runner diameter from sprue to cavities at each branching of the system; and 5) an over-run of the runners past the gates, or past the secondary sprues if center-gated, and also at appropriate junctions in the system to function as cold-slug wells.

As a rule, runner diameter can be gaged by the thickness and size of the piece to be molded. Common sizes are 1/4 and 5/16 in. with a minimum of 3/16 in. recommended. Oftentimes, undersized runners rather than gate size are cause for such difficulties as mica, lamination, and lack of ease in mold fill. Thus, it is advisable when using restricted gating to be assured that runners are adequate before opening the gates. A runner connecting to a gate should not be tapered in its approach but should be kept full and should end in a hemispherical contour. This helps to minimize pressure loss.

Molding characteristics

See Table I, p. 660. To cover this extremely broad class of molding compounds over the flow grades commercially available, fairly wide ranges are used in the tabulation of figures in Table I. For example, some of the softer compositions can be molded as low as 350° F., whereas the harder, less-plasticized formulations may require as high as 500° F. Allowance for differences in injection molding machines, type of part being molded, mold design, etc., was also taken into account.

The approximate operating conditions are therefore offered only as a guide for start-up.

Cylinder temperature: A good rule-of-thumb, regardless of type or formulation, is to work at the highest cylinder temperatures feasible for good operation. This is important, particularly for the harder, higher-flow materials, in order to develop maximum impact resistance and elongation, to minimize molded-in stresses, and to avoid weak welds. This temperature is generally slightly below the point at which traces of discoloration occur. Some exceptions to this are found where other limitations are encountered prior to reaching this temperature level; i.e., defects such as flash, sinks, voids, heat marks, and vapor burns. These exceptions will occur for the most part with the lower-flow materials, where the need for approaching the discoloration point assumes less significance.

In molding ethyl cellulose, particularly where relatively thin sections are required, use of maximum allowable temperatures should receive special emphasis. If molded on the "cold" side, the piece may look good but is likely to be laminar, or have a peelable surface skin, and will tend to dull or "rub-up." Higher-flow grades are more apt to show these defects than the softer compounds.

Flow temperature as measured by the standard ASTM test, D569-48, is commonly used with the cellulosics as a means for control and identification. This is the temperature at which a plastic under 1500 p.s.i. pressure will flow through a standard 1/8-in. orifice for a distance of 1 in. in 2 minutes. It is recognized that the rates of shear and the conditions of temperature and pressure, in addition to other basic differences, are quite unlike those occurring in an injection molding process. For these reasons, the test is not a precise indication of relative molding characteristics, unless the plastics compared are from a given polymer-plasticizer system. Therefore, for example, it is not at all uncommon to have two cellulose acetate plastics of the same flow which differ significantly in molding characteristics.

In view of this, an unqualified use of flow to indicate molding temperatures should be considered as only a rough guide for start-up. The following approximations for average conditions are provided on this basis:

Flow[1]	*Cylinder temp.* (°F.)
H4 — H5	455 — 510
H2 — H3	435 — 495
MH — H	405 — 465
MS — M	370 — 430
S2 — S	340 — 400

If the melt in the cylinder is kept hot too long, it degrades. Top safe temperature for 20-min. exposure is 350 to 400° F.

Nozzle temperature: If the nozzle or cylinder heats are excessive, the plastic will drool. This is not only a waste of plastic but is objectionable in that some of the oozed material enters the sprue bushing prior to the injection stroke, becomes chilled, and may cause plugging at the cavity gate or surface defects in the part.

Mold temperature: Precision work requires close control. Proper coring of the die and a temperature-control unit capable of maintaining the circulating

[1] See ASTM test D569-48, 1955 Book of ASTM Standards, Part 6, p. 287, for definition of these flow designations.

TABLE I: Injection molding characteristics of cellulosics

(Recommended molding conditions for various section thicknesses)

Thickness of section:	*less than ⅛ in.*	*⅛ to ¼ in.*	*over ¼ in.*
A. Temperatures, °F.			
1) rear cylinder	340-510	340-490	340-480
2) mid cylinder	340-510	340-510	340-510
3) forward cylinder	340-510	340-510	340-510
4) nozzle	300-460	300-460	300-460
5) mold face or mold coolant	70-180	70-180	70-160
6) melt leaving nozzle	330-450	330-430	330-430
B. Pressure exerted on material by ram, p.s.i.			
1) in standard cylinder	10,000-20,000	10,000-20,000	10,000-20,000
2) in injection cylinder of preplasticating machine	—	—	—
C. Timing			
1) total cycle (including mold-open time), sec.	10-60	20-90	40-150
2) ram forward time, sec.	5-30	10-40	20-60
D. Recommended gate dimensions[1] (assuming cavity volumes of 1, 4, and 16 cu. in. for the three section-thickness classes)			
If round, diameter, mils	25-50	25-50	25-50
land length, mils	40	40	40
If rectangular, depth, mils	25-50	25-50	25-50
width, mils	50-100	50-100	50-100
land length, mils	30-40	30-40	30-40
E. Shrinkage allowance, mils/in.	Without annealing	Without annealing	Without annealing
1) in direction of flow	2-7	2-15	4-25
2) perpendicular to flow	2-7	2-15	4-25

[1] Gating dimensions listed are based on the restricted type of gate and are applicable as starting recommendations for all cavity sizes within the given limitations. Gates may be enlarged, particularly in the large-size, heavier-thickness cavities, if necessary. See also text, p. 658.

water at ±2° F. are essentials. Optimum temperature level will depend primarily on size and thickness of the part and on the plastic formulation. For relatively high-flow compositions, especially where long, very thin sections are being molded, temperatures as high as 180° F. may be needed. For the softer formulas, a low in the vicinity of 70° F. is not uncommon. However, most jobs will fall within a 120 to 160° F. range. For obtaining maximum surface gloss, plus minimum weld lines and flow marks, the highest temperature which will provide adequate set within the cycle limitations should be used.

Pressure: In general, the optimum is a combination of maximum pressure and minimum booster which will provide unhesitating fill without encountering flash or sinks.

Cycle: The cycle is primarily governed by section thickness, plastic formulation, cylinder temperature, die temperature, and the ease of ejecting the molded part from the cavity. The injection portion of the cycle should be of adequate length for setup to occur at the gates of the cavities. Otherwise, flow-back with resultant sinks or voids in the part will occur. The cooling portion of the cycle should then be the minimum needed for prevention of distortion on ejection and during further cooling.

Purging routine: Purging is done with commercial purging compound, scrap, or the material to be molded. Purging is generally necessary at start-up, or after excessive heat exposure due to hold-up or when changing over from another material.

Design of molded part

Prior to new die construction, first consideration should be given to the design of the article.

Dependent on design and important for successful molding are: 1) flow of the plastic in filling the cavity; and 2) ease of ejection of the molded part.

The general shape and dimensions of the proposed molding and the gate location are principal factors affecting flow through the cavity. Their combined influence should be directed toward achieving an unhesitating, balanced progression of the plastic during cavity fill. If flow from the gate to the extremities is not uniform, or if the flow becomes divided, trapping of gases and weld lines are likely. Wall thickness is a very important controlling feature, and even small variations toward an unbalanced condition can cause trouble. Sudden changes in the thickness should also be avoided because of a shrinkage differential on cooling which is likely to cause distortion or highly stressed areas. On center-gated items, it is good practice to provide a gradual decrease in the wall dimension as the distance from the gate increases. This tends to prevent unbalanced fill; furthermore, with deep-drawn parts, the draft obtained is necessary for ejection.

Where holes and inserts are re-

quired, it is well to avoid, if possible, square or rectangular shapings, since flow at these points tends to cause a weld line and also pigment orientation.

No matter what the final design is to be, however, the recommended molding conditions listed in Table I, p. 660, can be taken into account. These recommendations have been broken down to provide for variations caused by differences in wall section thickness. The three categories covered are: section thicknesses less than ⅛ in.; section thicknesses between ⅛ and ¼ in.; and thicknesses over ¼ inch.

INJECTION MOLDING POLYTRIFLUOROCHLOROETHYLENE*

Polytrifluorochloroethylene (TFCE) may be injection molded successfully in conventional equipment, although temperatures required for processing are higher than those for most other polymers. Injection pressures are also generally higher—40,000 to 60,000 p.s.i. are not uncommon—although pressures as low as 20,000 p.s.i. can be used. Because of the ever-present danger of molecular-weight degradation, it is recommended that pressure rather than cylinder temperature be increased when better mold fill-out is desired. The geometry of the casting and mold design, as well as the ratio of cylinder capacity-to-weight of shot, are also of prime importance. Table I, right, is suggested as a starting point for most molding jobs, although proper molding conditions should be determined by experimentation in each case.

TABLE I: Suggested injection molding conditions[1]

Fluorothene grade:	*FYTD*	*FYTH*	*FYTS*
Cylinder temperature, °F.	520-560	540-580	560-600
Mold temperature, °F.	280-300	280-300	280-300
Ram pressure, p.s.i.	20,000-30,000	20,000-30,000	20,000-30,000
Injection dwell, sec.	10-50	10-50	10-50
Clamping dwell, sec.	10-30	10-30	10-30
Total cycle, sec.	30-90	30-90	30-90

[1] Based on Bakelite Co. materials.

Due to the extremely high viscosity of TFCE, small passages such as pinpoint gating should be avoided. Streamlined flow and minimum restriction in sprues and runners are necessary to avoid the use of excessively high cylinder temperatures and/or injection pressures.

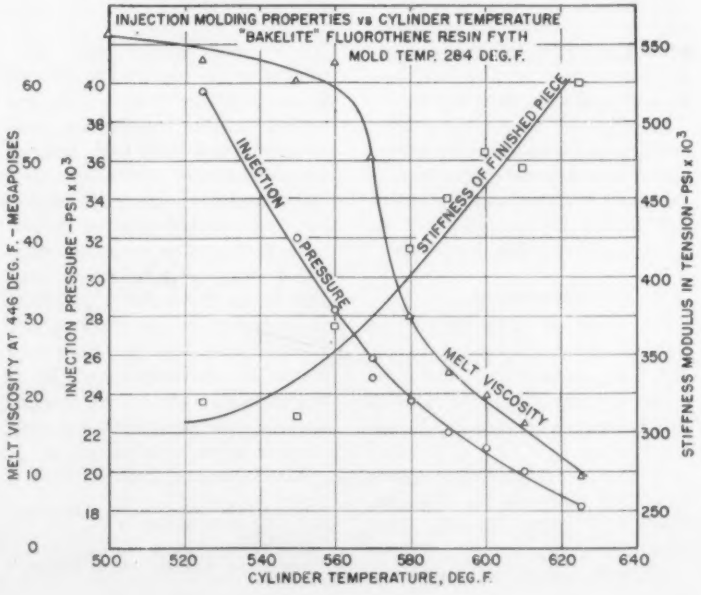
Figure 1, right, illustrates the effect of cylinder temperatures on injection pressure, melt viscosity, and stiffness modulus of the molded item. The effects of mold temperature on injection pressure and mold shrinkage are illustrated in Fig. 2, p. 662. The more rapid cooling rate which accompanies the use of lower mold temperatures aids in producing parts of greater transparency. Figure 3, p. 662, illustrates the effects of cylinder temperatures and mold temperatures on injection pressure. As can be seen from these figures, melt viscosity of the compound being molded is of prime importance. The data presented in these figures represent conditions for molding an A.S.T.M. Type 1 end-gated tensile bar on a 3-oz. press. The results, of course, would vary with changes in the type of mold or injection machine.

When heated above its melting point, TFCE is quite corrosive to many metals and organic contaminants. It is recommended that all metal surfaces that contact the hot polymer be chrome-plated, unless, of course, the metals are highly corrosion-resistant, e.g., No. 304 stainless steel and such alloys as X nickel, Xalloy 306, and Hastelloy Alloy B. Contaminants such as polyethylene, vinyls, or other organic matter may seriously degrade TFCE at processing temperatures.

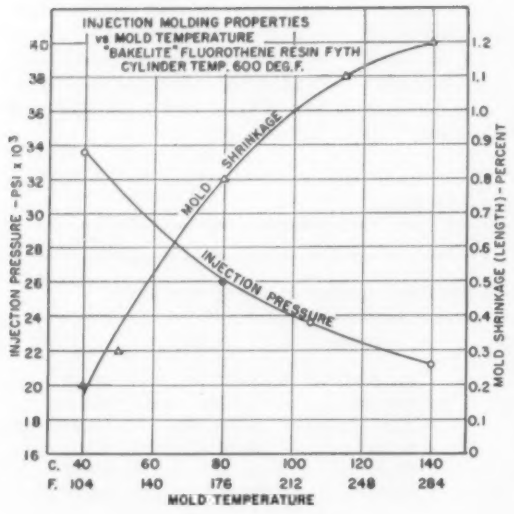
Molding characteristics

Some general recommendations can be made with regard to the molding of polytrifluorochloroethylene. For one thing, most

Fig. 1: Effect of cylinder temperature on injection pressure, melt viscosity, and stiffness modulus of molded polytrifluorochloroethylene



*Based on information supplied by Bakelite Co., Div. Union Carbide Corp., New York, N.Y. References were prepared by the editors.



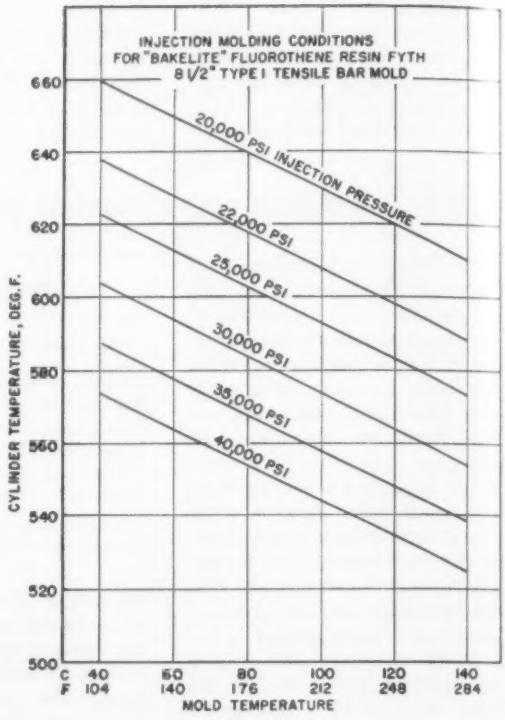


Fig. 2 (above): Effect of mold temperature on injection pressure and mold shrinkage. Fig. 3 (right): Effect of cylinder temperature and mold temperature on injection pressure. The data presented in these figures represent conditions for molding an ASTM Type 1 end-gated tensile bar on a 3-oz. injection molding machine

gates used when molding the material are ⅛ in. or greater and are center-gated. Another factor to bear in mind is that if the melt in the cylinder is kept hot too long, it degrades and the molded pieces suffer from discoloration, brittleness, poor surface, etc. Top safe temperature for 20-min. exposure is 400° F.

Predrying of molding powder can be done in a circulating-air oven. Recommended drying times are from 1 to 2 hr. at a temperature of approximately 200° F.

Purging may be necessary when molding polytrifluorochloroethylene if the material degrades and discolors. In this event, the cylinder should be purged until no more discolored TFCE appears.

References

For further information on fluorocarbon materials, see p. 119. For data on extrusion of fluorocarbons, see p. 725. Also consult the Subject Index and the Directory Index.

"Upgrading fluorocarbon moldings," by Carmen R. Gianotta, MODERN PLASTICS *32*, 125 (Oct. 1954).

"Determination of apparent molecular weight of polychlorotrifluoroethylene," by Kaufman, Kroncke, and Gianotta, MODERN PLASTICS *32*, 146 (Oct. 1954).

"Molded fluorocarbon applications," MODERN PLASTICS *32*, 202 (September 1954).

"Fluorocarbons face fame and fortune," MODERN PLASTICS *30*, 79 (Dec. 1952).

"Trifluorochloroethylene (Molding the 'specialized' plastics)," by J. A. Jupa, MODERN PLASTICS *28*, 84 (Dec. 1950).

INJECTION MOLDING NYLON

BY LOUIS PAGGI*

Since good quality and close tolerances are specified in most of the applications of nylon, the injection molding operations must be performed with care and all variables closely controlled.

Successful molding of nylon requires consideration of certain basic factors. For example, nylon has a sharp melting point (e.g., 487° F. for Zytel 101[1]). At molding temperature, the material has a lower melt viscosity than conventional thermoplastics. It is therefore necessary to modify conventional equipment and procedures when molding nylon.

Plasticating cylinder: With a correctly designed nozzle and proper distribution of heat, injection cylinders of all designs can be used for molding nylon. In general, it is found that horizontal diverging-type cylinders (Figs. 1 and 2, p. 663) and vertical cylinders can be heated to a higher over-all temperature than is possible with horizontal straight-bore cylinders.

Failure to carry sufficiently high temperatures at the rear section of diverging and multi-channelled cylinders may result in bridging of the granules, causing drooling at the nozzle, loss of injection pressure, local degradation of the material, and reduced output.

The type shown in Fig. 1 (typified by the De Mattia, HPM, Impco, Fellow-Leominster, Reed-

* Polychemicals Sales Service Laboratories, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

References were prepared by the editors.

[1] Trademark of E. I. du Pont de Nemours & Co., Inc.

Prentice, and Watson-Stillman machines) has no heating band over the course traveled by the plunger. The rear heating zone is at the rear section of the spreader. For this type of cylinder, the highest temperature (600° F. or hotter, depending on thickness of section, cycle, etc.) should be maintained at the rear band (measured at the center of the heater band). A temperature about 50 to 150° F. lower is maintained over the front portion of the spreader section. The temperature at the extreme front end of the cylinder should be just high enough to keep the material moving through the nozzle—as low as 400° F. on fast cycles, or as high as 500° F. on slow shots.

In the cylinder design shown in Fig. 2 (exemplified by the Lester and Van Dorn machines), the rear heating zone overlaps a section of the plunger stroke. The rear band of such a cylinder should be heated only to about 450° F. The higher temperature is applied at the main body band. For the front portion of the spreader and the extreme front end of the cylinder, the same general rules apply as for the cylinder in Fig. 1.

Nozzle: Recommended for molding nylon is a nozzle with a reverse taper bore at least 1 in. in length. This, in effect, extends the sprue into the heated nozzle. This design permits operation of the nozzle at a lower over-all temperature, eliminates the likelihood of a hot spot at the rear of the nozzle, and provides good control over drooling. For the best results, this type of nozzle should be provided with a heater band of sufficient wattage to maintain a temperature of at least 600° F. This band should be located as close as possible to the outlet of the nozzle and the sprue bushing, and should not exceed 2 in. in length.

It is important that the nozzle be adjusted to the sprue bushing only after the plasticating cylinder is up to molding temperature. If the nozzle is tightened against the sprue with a cold cylinder, the thermal expansion of the cylinder will wedge the nozzle too tightly against the hard sprue bushing, causing peening-in of the front opening. A damaged nozzle will not operate as designed and is hard to control.

At least one commercial machine is equipped with a nozzle having a mechanical shut-off. This type of nozzle has proved successful in molding nylon; in fact, it offers certain advantages when molding over inserts, or when very hot material is required at the front end of the cylinder, as when molding extremely thin-walled sections.

Mold design: Special mold construction is not required for nylon. Although molten nylon is more fluid than other thermoplastics, it will solidify almost at the instant of contact with the relatively cold mold surface, thus eliminating any undue tendency to flash. When flashing occurs, the line pressure should be reduced but the high rate of injection maintained. It should be noted that a common cause of flashing as well as surface burns is due to insufficient venting of the cavities. Because of the high rate of injection necessary for nylon, good venting of cavities is important at the spot where air traps. The preferred method of venting is an overflow button or slug positioned diametrically opposite the filling gate and connected to the cavity with a gate and runner of approximately ½ the cross-section of the filling gate.

Rough ground parting lines would be a second choice.

Lapping of the mating surfaces of the cavities is not recommended when injection molding.

Molds for articles which do not demand close tolerances can be designed by using data accumulated through experience or by allowing for a shrinkage of 0.010 to 0.040 in./in., depending on the wall section of the article. When close tolerances are required, however, the following mold construction steps are recommended:

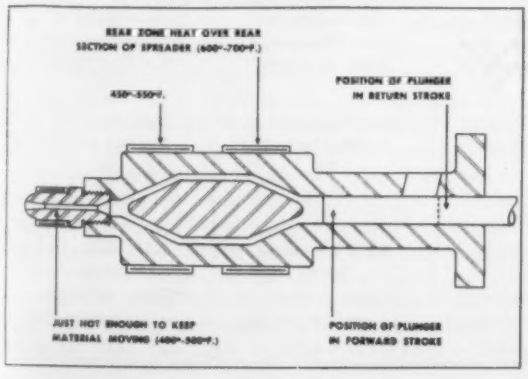
1) Using the specified dimensions, machine a single cavity in the mold-base intended for use in production.

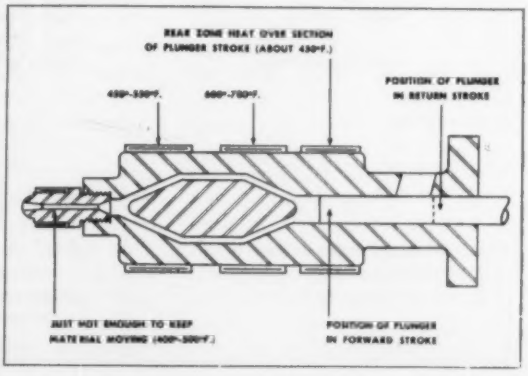
2) Machine the sprue bushing and all runners up to the positions where the production cavities will be inserted. This will establish the time required for the material to reach the cavities.

3) By trial moldings in the single cavity, determine optimum runner and gate size, and determine the best molding conditions required.

4) Heat-treat the molded part

Figs. 1 and 2: With proper distribution of heat, cylinders of all types can be used for molding nylon. Of the two major types of heater distribution, the cylinder in Fig. 1 (left) requires higher rear zone temperatures because the heater band does not extend over the plunger path





for ½ hr. at 350° F., and allow to cool slowly. (See paragraphs on "Heat-treating," p. 665.)

5) Check dimensions of the treated article after at least 24 hours. Note changes in any dimension.

6) Use shrinkage data thus obtained to adjust the dimensions of the production mold which is to be constructed.

Gating: See Sec. D, Table I, below. In general, runners should be between ⅛ and ⅜ in. in diameter. For articles having a wall thickness of ⅛ in. or less, runners need not exceed ⅛ in. in diameter. For articles of heavier wall thickness, the diameter of the runners should usually be about ½ to ⅔ the thickness of the article, though not exceeding ⅜ in. in diameter.

Dimensions for gates are given in Table I, below. If possible, gates should be flared toward cavities.

Predrying

Material molded with a moisture content above 0.25% will give moldings or extrusions with reduced toughness. The molding powder should therefore be stored in covered, moistureproof containers. Hoppers of machines should also be covered to minimize contamination by moisture.

It is recommended that nylon be molded fresh from the can. After opening the shipping container, nylon molding powder can stand (on humid days) for only 20 min. before predrying is necessary. Drying can be done in a dehumidified air oven at 175° F. Drying time would be between 3 to 6 hr. for virgin material and 12 to 24 hr. for reground material.

Molding characteristics

See Table I, below.

Molding temperatures: In many cases, the use of higher molding temperatures (600 to 700° F.) improves the properties of the molded piece (especially toughness), permits the use of smaller runners (hence gives less scrap

TABLE I: Injection molding characteristics of nylon
(Recommended molding conditions for various section thicknesses)

Thickness of section:	*less than ⅛ in.*	*⅛ to ¼ in.*	*over ¼ in.*
A. *Temperatures, °F.*			
1) rear cylinder	600–700	600–650	600–625
2) mid cylinder	550–650	525–600	525–550
3) forward cylinder	525–600	510–525	500–510
4) nozzle	To suit	To suit	To suit
5) mold face or mold coolant	70–200	140–200	180–200
6) melt leaving nozzle	525–575	510–520	500–510
B. *Pressure exerted on material by ram, p.s.i.*			
1) in standard cylinder	15,000–30,000	15,000–30,000	15,000–30,000
2) in injection cylinder of preplasticating machine	Not recommended at present		
C. *Timing*			
1) total cycle (including mold-open time), sec.	30	30–60	60 sec./¼ in. section
2) ram forward time, sec.	20	20–40	40 sec./¼ in. section
D. *Recommended gate dimensions (assuming cavity volumes of 1, 4, and 16 cu. in. for the three section-thickness classes)*			
If round, diameter, mils	30 to ½ thickness of part	30 to 120	120 to 180
land length, mils	Same as above	Same as above	Same as above
If rectangular, depth, mils	Equal to ½ dia. of gate	Equal to ½ dia. of gate	Equal to ½ dia. of gate
width, mils	Area equal to round dimensions	Area equal to round dimensions	Area equal to round dimensions
land length, mils	Same as above	Same as above	Same as above
E. *Annealing*			
1) medium	Glyco wax S932 or Teresso 140 oil.	Glyco wax S932 or Teresso 140 oil.	Glyco wax S932 or Teresso 140 oil.
2) temperature, °F.	300	300	300
3) time, min.	10–15	15–30	30
F. *Shrinkage allowance, mils/in.*	With annealing	With annealing	With annealing
1) in direction of flow	15–20	20–30	30–40
2) perpendicular to flow	Same as above or use test cavity	Same as above or use test cavity	Same as above or use test cavity

and shorter cycles), and increases the plasticating capacity of the machine from two to four times that possible with temperatures of 550 to 600° F.

Moldings of thin section, produced in short cycles and at high rates of material consumption, require higher cylinder temperatures than moldings of heavier section, longer cycles, and low rates of material consumption. For example, in the case of a 6-oz. shot being molded on an 8-oz. machine at a rate of about 11 lb. of nylon per hr., a temperature of 520 to 600° F. is indicated. If the same 8-oz. machine is used to mold a 2-oz. shot every 20 sec. (or about 22 lb./hr.), a higher temperature will be required. An output of greater than 40 lb./hr. on the same machine may necessitate cylinder temperatures as high as 720° F.

Mold temperatures: In general, the temperature of the mold should be about 100° F. Lower temperatures may be used when extreme toughness in thin sections is desired. Temperatures as high as 250° F. may be used when a more stress-relieved article is desired but where extreme toughness is not absolutely necessary.

Molding cycles: Articles with nonuniform cross-section, in which edges or surfaces must be extremely straight or flat, will usually require longer cycles.

Purging routine: After 15 min. delay, purge repeatedly until ram labors.

Heat-treating

To insure against any dimensional change caused by stress-relief, it is important that residual stresses be relieved by heat-treating the articles soon after molding.

It is recommended that heat-treating of nylon be carried out in the absence of air, preferably by immersion in a suitable liquid. The temperature of the heat-treating liquid should be well above the temperature to which the article of nylon will be exposed in use, preferably about 350° F. This will insure against dimensional change caused by uncontrolled stress-relief occurring below this temperature. Upon removal from the heat-treating bath, the molded article should be allowed to cool slowly in the absence of drafts; otherwise new surface stresses may result. A simple way of insuring slow, even cooling is to place the heated article in a cardboard container.

High-boiling hydrocarbons, such as oils or waxes, may be used as heat-transfer medium if the deposit left on the surface of the article is not objectionable. The minimum immersion time required for heat-treating is 10 min. for articles having a wall thickness less than ⅛ inch. Articles of heavier cross-sections may need up to 30 minutes.

Defects and causes

Blisters and splay marks: a) Wet or overheated materials; b) slow filling of mold; c) front of cylinder too hot, rear too cold.

Weld marks: a) Material too cold; b) pressure too low; c) slow filling of mold; d) poor venting.

Burn marks on surface: a) Poor venting; b) filling too fast.

Discoloration or brown streaks: a) Rear heat of cylinder too high; b) too much wattage over section of cylinder where injection ram works; c) insufficient pad of material between ram and cylinder after shot is taken; d) ram outtime too long; e) long delays between cycles; e) machine operating a short time after start-up.

Reduced toughness: a) Wet or overheated material; b) mold too hot; c) nonuniform wall sections in part; d) sharp angles in flow within the cavity (Where possible, use radius at meeting of any two sections.); e) wrong position of gate (Do not locate gate at any point where flexing occurs.); f) gate too sharp at entry to cavity (Blend with generous radius.); g) excessive dirt, fillers, or pigments used in material.

Inability to hold dimensional tolerances: a) Erratic performance of hydraulic or electric systems of machine; b) nonuniform cycles; c) gates too small and/or too long; d) runner system too long or too complex; e) too many cavities; f) worn clamp platen bearings; g) mold leader pins binding; h) nonuniform feeding of material; i) material not uniformly dried.

Ejection difficulties: a) Insufficient draft angle; b) cavity surfaces too smooth; c) cycle too short or too long; d) material injected too hot; e) wrong type of knock-out; f) wall sections too thin; g) pressure too high or low.

Internal voids and surface sinks: a) Pressure too low; b) cycle too short; c) filling rate too fast; d) material too hot; e) gates too long and/or too small; f) runners too small; g) lack of radii in flow stream.

Hazards

Nylon is not a dangerous material to handle, provided it is recognized that it is very hot and very fluid in its molten state. Moisture in the nylon does not make it more dangerous.

In general, molding powders heated to elevated temperatures in a confined space expand considerably and generate pressure which, when released, can cause molten material to be expelled from the cylinder with considerable force. Long delays in the molding cycle increase the possibility of violent ejection, particularly if the material in the rear section of the plasticating cylinder and the material in the nozzle are allowed to solidify due to a temperature drop, while the center and front sections are maintained at well above the melting point. This results in the formation of a solid plug of plastic at either end of the molten material under pressure. To prevent this from happening, the nozzle should be free from contact with the sprue bushing during the heating period prior to molding. The nozzle and front end of the cylinder should be heated first and maintained at a temperature at least 50° F. above the rest of the cylinder. As soon as the plastic flows from the nozzle, the remainder of the cylinder may be set to the proper molding temperature. When the rear temperature is sufficiently high to permit moving the ram, at least one air shot should be taken before locking the nozzle against the sprue bushing. The rear temperature of the cylinder should then be maintained high enough to allow free movement of material entering the rear zone.

If the melt in the cylinder is

kept hot too long, it degrades and the molded pieces are liable to suffer from such defects as discoloration, brittleness, poor surface, etc. The top safe temperature for 20-min. exposure is 550° F.

References

For further information on nylon materials, see p. 130; on injection molding equipment, p. 893. For data on the extrusion of nylon, see p. 717. Also see Subject Index and Directory Index.

"Polyliner improves injection molding," E. C. Bernhardt and L. Paggi, MODERN PLASTICS *33*, 109 (Feb. 1956).

"Engineering nylon gears," MODERN PLASTICS *31*, 109 (Sept. 1953).

"Injection molding of nylon," MODERN PLASTICS *30*, 90 (Jan. 1953).

"Current techniques for the injection molding of nylon," by L. Paggi, MODERN PLASTICS *29*, 101 (May 1952).

"Nylon—its properties and applications," by R. Luire, Mat. & Methods *36*, 79 (July 1952).

INJECTION MOLDING BRANCHED POLYETHYLENES

BY G. W. JARGSTORFF*

With the increased use of branched (low-density) polyethylenes in a larger variety of molded objects, extensive investigations have been initiated to study the important factors involved in their injection molding. The results of these studies have been primarily a rather clear definition of the importance of each factor in the injection molding process. Briefly, the results confirm field experience that the injection temperature or stock temperature is of primary importance. Two other major variables —injection pressure and mold temperature—were found to have an effect which is of lesser degree.

Figures 1 and 2, below, and also figures 3, 4, and 5, p. 667, show a marked effect on select properties with the variation of material temperature during injection. In the tests on which these graphs are based, temperatures ranged from 350 to 550° F. (as measured from molten stock on cycle). Mold temperatures were varied at each injection temperature used, from 70 to 130° F.; injection pressures were varied at each of the combinations of both of the temperatures.

Since the data shown were assembled from results obtained from a single machine and mold, absolute values may not be applicable to specific conditions in the field. However, the trends shown are entirely valid and have been corroborated for a number of different grades of polyethylene. They may therefore be applied as a guide to the injection molding of polyethylene regardless of the machine or the mold that is used.

Injection temperatures given in the figures are the actual temperatures of the molten material, taken by needle pyrometer measurements on cycle. Experience has demonstrated that the actual stock temperature, in the majority of cases, runs well below that of the cylinder as read from indicating instruments. The importance of determining actual stock temperature in the injection molding of polyethylene, or any other thermoplastic, will become apparent later in the discussion.

How properties change

Referring to the figures for each property, it is found that, as the injection temperature increases, tensile strength in the direction of flow decreases asymptotically to a minimum (i.e., approaches a minimum value as a limit); brittle temperature improves; stress-cracking resistance is increased; gloss and skinning resistance to surface delamination are improved; and shrinkage decreases asymptotically.

It may seem odd that raising the stock temperature should *decrease* the shrinkage since plastics expand with rising temperatures. It would be expected that, other factors remaining the same, if the melt were injected at higher temperature, having further to cool, it would shrink more, not less. The clue lies in the phrase "other factors remaining the same." As the stock temperature is raised by raising the cylinder temperatures, a much larger fraction of the cylinder contents is melted. The pressure drop between ram and nozzle, consumed in forcing the cold granules into the constricted heating zone, is greatly reduced. Thus the stock pressure in the mold increases even though the ram pressure has not been changed. This increase results in higher melt density with a corresponding expansion of the piece due to decompression when it is ejected from the mold. Since the percentage increase in stock pressure is much greater (quite possibly 100% or more) than the increase in *absolute* temperature of the stock (roughly 10% for a rise of 80° F.), the pressure effect more than offsets the temperature effect, with the observed results.

This interaction of molding factors is unavoidable and points up the need for measuring not only stock temperature but also *stock pressure* and stock injection rate. Ram pressure is as little useful as cylinder temperature in establishing the state of the stock.

From the above analysis, it is plain that increasing the length of a short cycle will have some of

* Development Laboratories, Bakelite Co., Bound Brook, N. J.
References were prepared by the editors.

Fig. 1: Variation of tensile strength with injection temperature changes

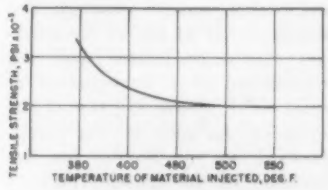
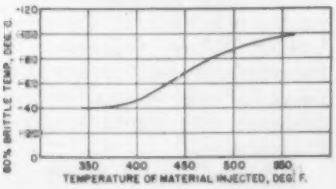


Fig. 2: Variation of 50% brittle temperature with injection temperature changes



the effects of raising the cylinder temperature. The effects of using a preplasticator may also be predicted from the same considerations.

Strength vs. temperature

It may be stated generally that better polyethylene moldings are obtained when higher material temperatures are employed. Although tensile strength in the direction of flow is greater at lower injection temperatures, this is an anisotropic effect due to orientation (i.e., values vary depending on the direction of measurement); strength transverse to the direction of flow usually suffers. As the injection temperature increases, the tensile strength of the piece may be observed to approach that of compression molded polyethylene; anisotropy diminishes and shrinkage values are found to be lower in the direction of flow. The degree of anisotropy induced during molding will also vary from application to application, depending on the particular mold design, other conditions being constant.

It may thus be stated that the properties of injection molded polyethylene are strongly dependent on the fluidity achieved in the heating cylinder and on the fluidity and resistance of the runners, gates, and cavity sections to flow during the short but critical period required to fill.

Pressure vs. properties

Pressure also affects the properties of the molded piece, but to a lesser degree. Most properties, such as stress-cracking, skinning, and brittle temperature, are affected only slightly by pressure at any injection temperature. Shrinkage is decreased and tensile strength is materially decreased in the direction of flow by increased injection pressure. The effect of pressure is more pronounced at lower injection temperatures. By increasing pressure and filling the mold faster, a greater average fluidity is maintained in the mold during filling.

The effect of mold temperature on properties is not significant with the exception of gloss, which is generally improved by higher mold temperatures. The effect of mold temperature on cycle is small at injection temperatures below 450° F., but at higher temperatures it becomes rather critical, having a large direct effect on cycle. In addition, since changes in cycle length affect stock temperature and pressure, there are effects which are indirect, as well.

Table I, p. 668, summarizes suggestions for improving the injection molding performance of most commercial grades of polyethylene resins. Inevitably some compromises will have to be made where two properties require different techniques. In these cases the individual application will determine the proper procedure to be followed.

Molding techniques

Obviously, the length of cycle is an extremely important economic factor in injection molding. The emphasis in every injection molding job is on minimizing the cycle. As a result, machines in the field today are running materials on ever-shorter cycles. Molders are also interested in getting as large a shot as possible out of a given machine. This has been responsible for the development of preplasticators and higher-wattage heating cylinders.

These two factors are loading present machines to their limit and in many cases overloading them, with the result that material temperatures are falling far below those indicated for the injection cylinder itself. It is apparent that as cylinder throughputs increase and cycles decrease further, material temperatures will continue to drop even though indicated cylinder temperatures remain the same.

Product quality

The quality of the injection molded product is highly dependent on the melt temperature during injection. Therefore it is not enough merely to soften material to the point where it will fill a mold; rather, the material must be delivered at the proper temperature and plasticity for a given mold to obtain optimum properties. Thus, when reference is made to the plasticating capacity of an injection machine, it is not

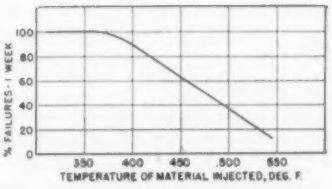


Fig. 3: Variation of stress-cracking resistance with injection temperature changes

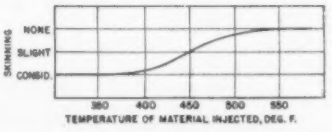


Fig. 4: Variation of skinning resistance with injection temperature changes

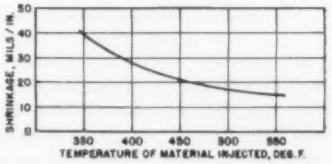


Fig. 5: Variation of shrinkage with injection temperature

enough to specify merely the rate of throughput; the temperature of the material in question being delivered at that rate of throughput is another important specification which must be made.

In cases where there is some latitude in temperatures available on a given machine for the fastest throughput possible, the next question is that of the temperature to select for a given molding application. This, of course, will depend on the particular configuration of the cavity to be filled. For pieces containing thin sections, higher temperatures will be required than for pieces having heavy-walled sections. The piece molded in the study mentioned above consisted of a thin plaque with a maximum thickness of 0.075 in. and a minimum thickness of 0.033 inch. In this case, in order to minimize skinning, stress-cracking, shrinkage, and orientation, and to get optimum low (brittle) temperature properties in the finished polyethylene piece, it was necessary to mold at material temperatures of 550° F. or higher. Since these thicknesses are in the range of wall thick-

TABLE I: Suggestions for injection molding polyethylene

Property desired	*Technique used*
Fast molding cycle	Min. stock temperature; min. mold temperature
High gloss	Max. stock temperature; max. mold temperature; restricted gating.
Improved fill out	Max. stock temperature; max. injection pressure
Low shrinkage	Max. stock temperature; max. injection pressure; min. mold temperature
Low warpage	Max. stock temperature; min. injection pressure; balanced mold temperature
Low brittle point	Max. stock temperature; max. mold temperature
Good skinning resistance	Max. stock temperature; min. mold temperature
High strength or stiffness in direction of flow	Min. stock temperature; min. mold temperature
Good stress-cracking resistance	Max. stock temperature

NOTE: Where "max. stock temperature" is recommended, reference is made to temperatures in the range of 550 to 600° F. In every case, however, maximum or minimum stock temperatures are those consistent with the quality desired. The choice of mold temperatures must be qualified by considerations of cycle as well as quality.

nesses commonly encountered in the molding of polyethylene in the field today, it is strongly recommended that molders check their material temperatures rather than rely on indicated temperatures.

In addition to thickness, consideration should also be given to the distance the material must travel in a mold through a given cross-section. Large pieces having thin sections would obviously require higher temperatures than large pieces with thick sections or smaller pieces of the same section. In any case, the higher the material temperature, within limits, the better the quality of the finished piece.

Softer-flow material

Because increased plasticity is an effect of increasing the temperature, it is also possible to employ polyethylene materials with softer flow properties at lower temperatures. However, this effect can be achieved only within certain limits since flow is a function of molecular weight, and softer flow is likely to be obtained at some sacrifice of physical properties. It is therefore obvious that the use conditions of the end product will to a degree determine and often limit the softness of flow.

Throughout this discussion, it has been recommended that higher molding temperatures be used. This implies longer cycles, since the injected melt will have to cool longer. The molder must naturally weigh the factors of quality required and allowable rejects against the speed of operation in judging the economics of the particular job.

In many applications in which quality is not critical and no trouble is encountered in fabrication, lower injection temperatures are acceptable to obtain shorter cycles, where cycle time is limited by setting time. However, investigations of minimum cycle have shown that mold temperature, although having little effect on cycle at low injection temperatures, is an important factor at injection temperatures which are high.

Indications are that it may be possible to control cycle by controlling mold temperature. That is, even though high injection temperatures are used, running a sufficiently cold mold may keep the cycle almost to the level achieved with lower stock temperatures. Of course, this partly offsets the effects hoped for in using high injection temperatures. Since the cycle would be critical with mold temperatures in this range, more efficient cooling and control in the mold would probably be required, with consideration given to better coring and to refrigerated coolants. Low mold temperature, although affecting cycle considerably, seems to have an insignificant effect on most properties of molded polyethylene, but it does decrease shrinkage.

Since the properties of injection molded polyethylene products are to a great extent dependent on the temperature of the material being injected, and since experience has shown that material temperatures often run well below indicated cylinder temperatures, the molder should check the actual material temperature while on cycle (by some means such as a needle pyrometer) to determine if the melt is at the proper temperature for optimum properties.

This is especially important as the ratio of shot weight-to-rated capacity increases and as cycle times decrease. In addition, for every molding job there exists a minimum temperature (consistent with good performance), depending on cycle, shot size, and configuration, below which poor properties may be expected. Generally, it is best to run as hot as is practical since the optimum minimum temperature is difficult to determine accurately. Running at high temperatures may require an increase in cycle but these increases can be kept to a minimum by proper mold design and the use of coolants which are more efficient.

References

For information on molding linear polyethylenes, see the article immediately following.

"Temperature and pressure measurements in the injection machine heating cylinder," by C. E. Beyer, R. B. Dahl, and R. B. McKee, MODERN PLASTICS *32*, 127 (Apr. 1955).

"(Polyethylene) molding techniques: mold design," MODERN PLASTICS *32*, 95 (Oct. 1954).

"New concept of hot runner molding," MODERN PLASTICS *32*, 123 (Sept. 1954).

"New switch on spouts," MODERN PLASTICS *31*, 140 (June 1954).

"Increasing molding efficiency," MODERN PLASTICS *31*, 105 (March 1954).

"Measurement of heating capacities of injection molding machines," by C. E. Beyer and R. B.

Dahl, MODERN PLASTICS *30*, 124 (Sept. 1952).

"Production of large polyethylene carboys," by E. Crosio, MODERN PLASTICS *29*, 101 (July 1952).

"Hot runner molds," MODERN PLASTICS *29*, 101 (June 1952).

"Role of pressure, temperature, and time in the injection molding process," by G. D. Gilmore and R. S. Spencer, MODERN PLASTICS *27*, 143 (Apr. 1950).

"Polyethylene pipe fittings," British Plastics *27*, 94 (March 1954).

INJECTION MOLDING LINEAR POLYETHYLENES

Phillips-Process Resins

BY J. VIRGIL SMITH* and J. N. SCOTT*

Marlex[1] 50 polyethylene is a linear polymer made by Phillips Chemical Co. The material, with a minimum amount of branching, has a crystallinity of 93 to 95 percent. It has excellent chemical resistance, low permeability, and good electrical properties.

In order to produce quality molded items, due consideration must be given to molding conditions, particularly mold design, gate design, gate location, cycle time, and the injection molding machine.

In filling a cavity, the polymer molecules will tend to line up (orient) parallel to the direction of flow. The degree of orientation is increased by the use of a smaller gate, thinner walls, and cooler mold temperatures. In certain applications, radial orientation will produce a more usable part. However, generally, where warpage is a problem, the degree of orientation should be kept to a minimum. Marlex 50 resin set up at a higher temperature may give a faster cycle for some parts. Through nonuniform cooling, it is possible to obtain a part with varying degrees of crystallinity and density throughout the part. This variation in density will contribute to warpage.

Equipment and molds

Equipment: With the flow characteristics and high solidification temperature of Marlex 50 resin and proper gating of the cavity, a large number of quality moldings can be obtained on a rapid cycle with standard machines and conventional feeding devices. However, in close-tolerance molding, the use of weigh feeders is recommended. Using the starved feeding technique, it is almost impossible to pack the cavity, but for some moldings, the commercially available weigh feeders operate too slowly to permit rapid molding cycles.

Normally, no special equipment is necessary when injection molding Marlex 50. For color dispersion, however, a dispersion nozzle is recommended.

Mold design: Suggested recommendations for mold design that will aid in the production of uniform parts in the shortest possible cycle are as follows:

1. Sprue and runner system should be as short as it is possible to make.
2. Full round gates should be used. (See Table I, p. 670, Sec. D.)
3. Cavities, where possible, should be center-gated for uniform fill.
4. Gate land length should be kept to a minimum to minimize pressure loss and excessive heat build-up in the gate area of the mold.
5. If warpage is a problem, gate diameter should be 0.070 to 0.250 in. I.D., depending on the thickness of the part and the weight of the shot.
6. Where possible, a localized cooler should be placed opposite the gate.
7. A localized ring cooler is recommended around the sprue-bushing. (Items 7 and 8 place maximum cooling in the area of greatest heat build-up.)
8. The extremities of the cavities should be cooled by separate cooling channels containing circulating water with temperatures ranging from 80 to 200° F.
9. Spiral-type channeling with the water inlet near the center of the mold and the exit at the extremity has proved to be very useful in the molding of flat center-gated items.
10. Cavity surfaces should be polished if a glossy surface is to be obtained on the part.
11. Air, ring, or pin ejection mechanisms are satisfactory.
12. Threads and other slight undercuts can be stripped from a mold that is properly designed.
13. The use of submarine gates or hot-runner systems permits automatic molding.

Molding characteristics

See Table I, p. 670.

Molding conditions: Since the material does not absorb water, no predrying is necessary. The maximum possible injection pressure and injection speed are recommended for molding Marlex 50 polyethylene parts. The employment of minimum injection time (forward plunger dwell) is desirable in the elimination of warpage in the molded item. In thin-wall moldings, the use of minimum injection time will insure the production of a tough molding without embrittlement in the gate area due to packing. In the case of heavy-walled items, a greater injection time will be required to pack the cavities to prevent sink and void formation.

If the melt in the cylinder is kept hot too long, it degrades. Top safe temperature for 20-min. exposure is 575° F. (in absence of air).

The total cycle time is a function of part design, mold design and the injection molding machine. With a well-designed mold, fast cycles can be obtained with Marlex 50 polyethylene since the material sets up at a high temperature. The part can be removed from the mold soon after injection is complete.

Mold temperatures: The best reproduction of the mold surface is obtained with high mold temperatures.

In thick-wall items, the elimination of sink marks can be obtained by using a low stock temperature and long injection time through a relatively large gate (125 mils I.D.). The mold temperature may vary from a cold mold to a hot mold (70 to 225°

* Plastics Sales Div., Phillips Chemical Co., Bartlesville, Okla.
[1] Trademark of Phillips Chemical Co.

TABLE I: Injection molding characteristics of linear polyethylene (Phillips-Process)

(Recommended molding conditions for various section thicknesses)

Thickness of section:	*less than ⅛ in.*	*⅛ to ¼ in.*	*over ¼ in.*
A. *Temperature, °F.*			
1) rear cylinder	450–550	350–550	300–500
2) mid cylinder	500–575	350–550	300–500
3) forward cylinder	500–575	350–550	300–450
4) nozzle	450–550	350–450	300–450
5) mold face or mold coolant	70–180	70–120	70–225
6) melt leaving nozzle	450–575	350–450	300–450
B. *Pressure exerted on material by ram, p.s.i.*			
1) in standard cylinder	12,000–30,000	8,000–30,000	4,000–30,000
2) in injection cylinder of preplasticating machine	10,000–30,000	6,000–30,000	3,000–30,000
C. *Timing*			
1) total cycle (including mold-open time), sec.	6 to 60	45 to 90	60 to 120
2) ram forward time, sec.	1 to 15	6 to 20	10 to 30
D. *Recommended gate dimensions (assuming cavity volumes of 1, 4, and 16 cu. in. for the three section-thickness classes)*			
If round, diameter, mils	25–250 (center gate)	50–375	75–75% of section thickness
land length, mils	minimum	minimum	minimum
If rectangular, depth, mils	—	—	—
width, mils	—	—	—
land length, mils	—	—	—
E. *Shrinkage allowance, mils/in.*	Without annealing	Without annealing	Without annealing
1) in direction of flow	20–40	20–45	20–60
2) perpendicular to flow	20–35	20–40	20–60

F.) depending on the part design. Actually, in selecting a mold temperature, several factors must be considered:

1) The thickness of the part to be molded: With thicker wall sections, higher mold temperatures are desirable.

2) The rigidity desired for the molded object: Low mold temperature results in some quenching of the polymer. This quenching or rapid cooling of the melt tends to reduce the crystallinity and thereby change the related Marlex 50 properties such as stiffness. This quenching effect is greater in thinner sections.

3) As mold temperature is raised, the ease of flow of the polymer into the mold is increased.

4) High mold temperatures require longer cycles.

Cylinder temperatures: Because of its higher softening temperature, Marlex 50 requires higher (50 to 100° F.) processing temperatures than branched polyethylenes. Surface gloss and flow improve as stock temperatures rise, but excessively high temperatures cause sink marks in thick sections.

Injection pressure: Marlex 50 requires 75 to 100% of the machine's maximum injection pressure, depending on the shape of the mold cavities, gate and runner dimensions, and injection-cylinder and torpedo dimensions. High pressures facilitate rapid filling of the mold, improve surface appearance, reduce shrinkage and warpage.

When molding sections in thicknesses less than ⅛ in., the pressure exerted on the material by the ram is 12,000 to 30,000 p.s.i. in standard cylinders; in thicknesses between ⅛ and ¼ in., the pressure is 8,000 to 30,000 p.s.i.; and in thicknesses over ¼ in., the pressure is 4,000 to 30,000 p.s.i.

Purging routine: Purging is necessary only when changing material, color, or after high-temperature operation. A low cylinder temperature minimizes time and material required to purge clean.

Ziegler-Process Resins

BY G. H. SOLLENBERGER*

and J. C. HOUSTON*

With a few variations, molding techniques for the higher-density polyethylenes parallel those used for the lower-density types. Some of the more important aspects are as follows:

1) *Polymers* in the melt index range of 1.0 to 9.0 are widely used for injection molding, producing parts having generally excellent properties and outstanding surface finish. Parts molded from materials of less than 1.0 melt index may display superior tensile strength, impact strength, and en-

* Technical Specialist, Market Development Section, Chemical Div., Koppers Co., Inc., Pittsburgh 19, Pa.

vironmental crack resistance, but such parts often have poor surface quality and may require considerably higher molding temperatures and pressures.

2) *Cylinder temperatures* may range from 300° F. for some applications to as high as 700° F. for the high-speed molding of thin-wall items. Basically, the cylinder heat should be sufficient to permit rapid filling of the mold.

3) *Injection pressure* and ram speed should both be as high as possible in order to fill the mold quickly.

4) *"Pressure dwell"* or *"ram forward"* time should generally be as short as possible, since "packing" the mold often results in a wavy surface around the gate and also increases the tendency to warp.

5) *Mold temperature* should be low, from 130° F. down to as low as 20° F. for extremely fast cycles and high-quality parts. If filling the cool mold should prove to be difficult at high cylinder temperatures and injection pressures, it may be advisable to use a polymer, which has a higher melt index, to open the gate and runner system, or to utilize an injection machine of sufficient capacity to handle the job. Dew collection on mold surfaces also limits the reduction of the temperatures of the mold.

6) *Gate design* follows usual plastics practice, and fan gates, pin-hole gates, and sprue gates have been proven satisfactory. Both high and low melt index polymers have been processed without difficulty by hot-runner and runnerless techniques.

7) *Warp*, resulting from the relatively high shrinkage of polyethylene, can be reduced by allowing a slightly longer cooling time in the mold. Post-molding warp can be virtually eliminated by the use of properly-designed cooling jigs and fixtures. In general, fast injection into a cool mold with minimum pressure dwell time will serve to minimize warp. Design including stiffening ribs perpendicular to the general surface reduces the tendency to warp.

8) *Mold shrinkage* varies from 2 to 4%, with more shrinkage appearing in the direction of the flow. Many factors may have a strong influence on part dimensions. For example, a cool mold or a quick quench upon removal from the mold will generally reduce mold shrinkage. Normally, the mold shrinkage increases with increasing cross-section and mold temperatures.

9) *After-shrinkage* of the magnitude of 2 to 4% may be observed if injection molded parts are subjected to elevated temperatures, such as 212° F. for 30 min., or 250° F. for 10 minutes. Preliminary data show that the *total* dimensional change (mold shrinkage plus after-shrinkage due to use exposure at elevated temperature) is usually in the 4 to 6% range. It is interesting to note that parts exhibiting low mold shrinkage have shown higher after-shrinkage, and vice versa. Naturally, allowance must be made for this in the case of assemblies which will be exposed to heat, especially if one part is exposed to heat and the other is not or if one part is higher-density polyethylene and the other is not.

INJECTION MOLDING POLYSTYRENE

BY ROBERT R. MOYER*

With the introduction of the first commercial styrene approximately 20 years ago, injection molding of the material was based on the equipment and the general molding techniques applied for the cellulosic plastics. By 1950, polystyrene had become the largest-volume thermoplastic to be converted by the injection molding process. Consistent with the rapid expansion in volume usage, fundamental study of material rheology and injection molding characteristics have been and continue to be conducted.

The effect of the latter work has been observed in the form of improved material end properties, conversion characteristics, and uniformity. For polystyrene in particular, injection molding machine development has embodied vastly improved rates of mechanical action, more efficient heater and hydraulic systems, increased capacity (1950—60 oz., to 1953—400 oz.) and supplied unique design features (e.g., direct multiple-nozzle small automatics and preplasticizers).

Obviously, the fundamental studies of both material and machines have required that the effect of mold geometry be overlooked or minimized if reproducible results of an accurate index of test values were to be developed.

Since commercial molding practice provides for mold geometries of unlimited variety and utilizes the "available" machine, some compromise with optimum polystyrene molding conditions must prevail.

Cylinder—temperatures: Table 1, p. 672, indicates typical heating cylinder settings for selected groupings of commercial injection machines. High and low (°F.) values are presented for each control zone. No center-zone values are listed for equipment up to 6-oz. capacity, although some commercial models offer this feature. Similarly either no value or Variac is listed for nozzle settings.

For machines in this smaller-capacity range, inclusion of a center-zone control and "off-on" nozzle heating will normally result in overcontrol of temperature with resultant over-ride of front-zone temperatures and alternate nozzle drooling or freezing. When extended nozzles or direct injection multiple nozzles are required, constant "input control" is preferred.

For equipment 8-oz. and up, a value of 450° F. has been chosen to emphasize the desirability of maintaining nozzle temperatures at a minimum of slightly above the true stock temperature. When extended nozzles or hot-runner tooling is involved, higher nozzle temperatures (500° F. or above) are required either to compensate for the added distance the polymer must travel or to reflect that the controlling temperature area is in the hot-runner system.

Several concepts and consid-

* Assistant Director, Technical Service, Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.

TABLE I: Typical heating cylinder settings for injection molding polystyrene

Machine type	Rear zone		Center zone		Front zone		Nozzle		Preplasticator Rear zone		Preplasticator Center zone		Preplasticator Front zone	
	Low °F.	High °F.	Low °F.	High °F.	Low °F.	High °F.	Low °F.	High °F.	Low °F.	High °F.	Low °F.	High °F.	Low °F.	High °F.
Standard 2 to 6 oz.	500	550	—	—	475	525	—	—	—	—	—	—	—	—
Automatic 2 to 6 oz.	530	630	—	—	530	580	Variac		—	—	—	—	—	—
Preplasticator 4 to 6 oz.	480	530	—	—	460	520	Variac		550	590	—	—	525	550
Standard 8 to 16 oz.	500	650	490	620	450	590	450	Variac	—	—	—	—	—	—
Standard 32 to 60 oz.	500	670	500	600	490	530	450	Variac	—	—	—	—	—	—
Preplasticator 16 to 48 oz.	400	500	400	500	400	500	450	Variac	550	700	550	680	550	680
100 to 400 oz.	400	500	400	500	400	500	Variac		550	700	550	680	550	680

TABLE II: Molding conditions for polystyrene

Part weight, oz.	Typical cross-section (in.) Low	High	Mold gate cross-section (sq. in.)	Over-all cycle (sec.) Low	High	Mold fill time (sec.) Low	High	Total plunger forward time (sec.) Low	High	Clamp (from plunger ret. to press open in sec.) Low	High
1	.018	.090	.00077	6	20	0.8	3	2	6	2	10
4	.050	.090	.00096	12	35	1	3	4	9	4	18
8	.070	.115	.00173	20	45	3	6	6	15	10	25
16	.090	.125	.02761	35	55	7	15	12	17	16	30
24 to 48	.090	.125	.04909	40	90	7	15	12	20	20	60
48 to 150	.090	.135	.04909	60	120	4	15	15	30	30	60

erations are important to the specific application of the value ranges in Table I, as follows:

1. Both the mold and the injection heating cylinder are heat exchangers which function as opposing systems, but which must achieve balance for economy.

2. Low mold tolerance for heat dissipation should be compensated for by use of minimum cylinder temperatures and optimum injection pressures.

3. With the exception of thick-section molding (above 0.150 in.) lower front-zone temperatures effect the most desirable plastication preparation and mold-fill characteristics.

Table II, above, is applied further to describe and relate molding conditions. Part-weight has been chosen in preference to full-shot weight since it allows a better definition of molding conditions. The low and high values for "cross-section" represent minimum piece part gage, exclusive of ribs or bosses.

Mold gate cross-section values are for single-gated parts. For parts weighing 16 oz. or over, the use of multiple gates is primarily dependent upon the shape of the part. Reductions in area of 30 to 50% are allowable with the use of more than one gate.

Cycle elements include both low and high values per second to reflect both actual practice and the variation which must result from differences in gage and geometry of parts of equal weight.

The majority of parts weighing 48 oz. or over are produced on preplasticating machines. Hence the mold-fill time, and often the plunger-forward time, are equal to or lower than for parts of considerably lesser weight.

The use of special equipment or tooling design must be related to a specific part design or requirements of production economics. Ball check nozzles, dispersion disks, and heaters of special design (e.g., polyliners) are of this nature and have proven their value, but are not absolute requisites for molding.

INJECTION MOLDING SPECIAL STYRENES

In addition to the standard or general-purpose styrenes which are injection molded by the techniques previously described, there are a number of "special" styrenes commercially available which require special molding techniques for the best results. The following discussion of these techniques and how they are to be used has been prepared by the manufacturers of each of the materials. These companies and their products are included: Bakelite Co. (C-11 styrene acrylonitrile copolymer and the TMD series); Dow (Styron special styrene series); Koppers (Dylene styrene family and Fibertuff glass-reinforced polystyrenes); Monsanto (Hi-Flow, LHA, Hi-Test, and Hi-Heat series); Marbon Chemical

Div., Borg-Warner Corp. (Cycolac acrylonitrile-butadiene-styrene multipolymers); and Naugatuck Chemical Div., United States Rubber Co. (Kralastic compounds, including Kralac H and Kralastic B, D, F, and J blends).

Bakelite

Special Bakelite polystyrenes include C-11 styrene acrylonitrile copolymer and family of impact-resistant materials. These are: a high-impact polystyrene, TMD-5151; an extra-high-impact polystyrene, TMD-2155; a high-heat-resistant high-impact polystyrene, TMD-5161; and a medium-impact polystyrene, TMD-8020.

The physical properties, molding characteristics, and heat distortion temperature of C-11 have been balanced to satisfy the requirements of the majority of applications. C-11 is more difficult to mold than polystyrene, but it is possible to use it in most molds designed for polystyrene by adjusting mold and cylinder temperatures, and sometimes gate size. Increasing speed of injection, using "starved feed," or using a preplasticator will often allow C-11 to be molded on polystyrene cycles. If a substantial increase in pressure appears necessary, there may be danger of over-packing and subsequent sticking in the cavity. It is then best to increase stock temperatures within the recommended limits. To attain the optimum heat-distortion resistance of C-11, it is advisable to use the highest permissible mold temperature and the fastest possible injection speed. C-11 is not compatible with polystyrenes and some other thermoplastics. Therefore, care must be taken to avoid contamination.

TMD-5151 molds in a similar fashion to standard injection molding grades of styrene.

For maximum surface gloss, higher mold temperatures than are generally employed in injection molding of the regular grades of styrene should be used. Optimum results are best obtained with mold temperatures ranging between 140 and 160° F., with a temperature of approximately 150° F. usually proving most satisfactory. Actual stock temperatures ranging between 390 and 490° F. are recommended for TMD-5151.

TMD-5161, a high-impact heat-resistant polystyrene, molds in a fashion similar to standard injection molding grades of impact styrene. Because it is a heat-resistant material, it has stiffer flow properties and is faster setting. Actual stock temperatures from 440 to 490° F. are recommended and best results are obtained with a mold temperature of 160 to 180° F. To obtain the optimum heat-distortion resistance of TMD-5161, it is advisable to use the highest permissible mold temperature and the fastest possible injection speed.

TMD-8020 molds more like the general-purpose polystyrenes than the other impact polystyrenes. Mold temperatures of 140 to 160° F. and actual stock temperatures of 390 to 490° F. are recommended.

Dow

BY GORDON B. THAYER*

Specialized formulations have been developed by Dow to provide molding materials with styrene as a basic monomer.

An extra-high-impact material, designated Styron 480, was recently introduced. This shock-resistant material has been formulated without sacrifice of heat distortion temperature, which is 185 to 192° F. In addition to toughness, it has good heat resistance and surface gloss. Its moldability and extrusion behavior are good and it is also being successfully calendered.

Styron 475 is a rigid thermoplastic material which has good impact strength combined with high percent elongation and somewhat lower modulus of elasticity than general-purpose polystyrene. A combination of high impact strength, high elongation, and medium-high modulus provides toughness which has been found to be suitable for many applications.

Styron 475 requires a mold temperature of 160° F. or higher to produce a lustrous surface. Generally, it is necessary to run the mold temperature at a point somewhat higher than the 160° F. temperatures.

The heat distortion temperature of Styron 475 is somewhat lower than that of general-purpose polystyrene, but it is sufficiently high to be satisfactory for most household appliances. This material has demonstrated excellent retention of impact strength and elongation upon aging. The material is not recommended for applications involving outdoor use or ultra-violet radiation.

Styron 700 has a heat distortion temperature which is considerably higher than that of general-purpose polystyrene as measured by A.S.T.M. methods. Although the heat distortion temperature of many articles molded from Styron 700 is likely to be greater than 212° F., the material is not recommended for prolonged or repeated boiling. It is recommended that Styron 700 be used for applications which require the highest heat resistance possible with injection molded polystyrene materials. Such parts should be annealed in order to obtain the maximum in heat and craze resistance in the finished products.

Mold temperatures should be generally above 180° F., although in some cases it is not practical to mold with the temperature this high. Mold and product design should be carefully examined if it is not possible to mold satisfactory pieces in molds at a temperature less than 180° F. High stresses are likely to be encountered if the mold cools, and annealing becomes extremely difficult if the molded part is highly stressed. A very long annealing time is required under such conditions in order to prevent distortion of the part during the annealing cycle. Furthermore, long annealing cycles result in greater tendency to warp, and, therefore, the annealing temperature has to be further reduced.

Styron 688 is a fast-flow, general-purpose polystyrene which has a heat distortion temperature approximately 10° F. below that of Styron 666. Other physical properties are about the same as those of general-purpose polystyrene.

Styron 689 is a newer and easier

* Plastics Technical Service, The Dow Chemical Co., Midland, Mich.

flowing formulation than Styron 638. The brilliant sparkle and freedom from haze add to the attractiveness of crystal parts molded with this material.

Styron 683 is a heat-resistant grade of polystyrene. It has a heat distortion temperature about 20° F. higher than Styron 666 and physical properties equivalent to, or better than, those of Styron 666.

Styrex 767 is a copolymer of styrene and acrylonitrile. It is a rigid thermoplastic which can be readily molded.

Before molding, drying of the material can be accomplished with air-circulating ovens and either infra-red or electric resistant-type heaters. Drying for 1 to 2 hr. at 170 to 190° F. is recommended. It is imperative that the heating cylinder be completely purged of all other thermoplastic materials before molding Styrex 767. Normal range of cylinder temperature is about 400 to 550° F. In general, these temperatures will be 50 to 75° F. higher for Styrex 767 than for general-purpose polystyrene employing comparable machine pressures. Controlled mold temperature is an important consideration in the molding of Styrex 767. If mold temperatures in the region of 170 to 190° F. (or higher) are used, the moldings will exhibit maximum heat resistance and minimum tendency to craze.

Koppers

BY R. P. McLANAHAN*

The Dylene[1] polystyrene family offered by Koppers Co., Inc., includes normal polystyrenes, as well as modified formulations such as high-elongation (high-impact) polystyrenes, medium-elongation polystyrenes, and a group of heat-resistant polystyrene materials.

One recent addition to the family of normal Dylene polystyrenes is Type 2, developed especially for the fast molding of very thin, large-area sections, e.g., disposable containers, cups, tumblers, vials, etc. Type 2 offers good clarity, ease of flow, moderately fast setup, and freedom from sinks and waviness.

Dylene 3 is a general-purpose material combining good flow and set characteristics with physical properties and heat resistance intermediate between the easiest-flowing formulations and the improved heat-resistant types of polystyrenes. It is best suited for molding parts of medium thickness.

Dylene 4 combines easy flow for rapid filling with fast setup and mechanical strength properties approaching those of the medium-heat-resistant polystyrenes. It is used for heavy-wall and mixed thin- and thick-section molding. Dylene 7 offers good flow and fast set characteristics.

Dylene 8 is a heat-resistant type polystyrene for molding and extrusion purposes. It offers high heat resistance, tensile strength, and flexural strength with uniform moldability. These properties are also retained in Evenglo[1] polystyrenes, a series of specially pigmented materials, that are highly resistant to yellowing, and are used primarily in lighting applications. Improved Evenglo polystyrenes with increased light stability, known as the PL-color series, were recently introduced.

The high-elongation (high-impact) polystyrenes include: Dylene 200, an easy-flowing type which exhibits improved surface gloss and weld appearance and is especially adaptable to large-area, thin-section molding; Dylene 708 which has superior electrical characteristics, particularly at high frequencies, and low moisture absorption; and Dylene 800, an improved heat-resistant material.

In the medium-elongation series, Dylene 30 and 80 offer a property range that falls between the normal polystyrenes and the high shock-resistant type materials. They both possess excellent surface gloss and good weld-line appearance. Dylene 80 is used where higher heat resistance is required.

Cylinder temperatures: Cylinder temperatures for the various Dylene polystyrene formulations may range from 350 to 600° F. Usually, those materials possessing higher heat resistance will require higher cylinder heats and injection pressures.

Cylinder temperature settings for Dylene 8, for example, will run 30 to 50° F. above those used for general-purpose polystyrenes. Molding conditions for Evenglo polystyrenes will parallel those used for Dylene 8. However, with the PL-color series, cylinder temperatures above 540° F. should be avoided.

High-elongation and medium-elongation polystyrenes usually mold at lower cylinder temperatures than their corresponding formulations in conventional polystyrenes. Both classes of polystyrene formulations are resistant to scorching as long as exceedingly high cylinder temperatures, or prolonged exposures, even at low cylinder temperatures, are not maintained.

Cylinder heats and injection pressures are also dependent upon a number of other factors, such as the type of gate, runners, and sprue design used, as well as machine capacity and the particular shape and size of the part or parts to be produced.

Mold temperatures: Mold temperatures of 140 to 180° F. will yield parts with the best surface gloss and mechanical properties. Mold temperatures below 140° F. generally produce parts with a satin or matte finish. Excessively cool mold temperatures may result in flow lines, weak unsightly welds, as well as loss of mechanical properties. When working with Dylene 8, mechanical strength is improved by high mold temperatures, preferably with a cooling time allowed which is sufficient to permit molding stresses to relax while the piece is in the mold.

Predrying: Normally, it is not necessary to predry Dylene polystyrenes before injection molding because of their low affinity for moisture. However, when polystyrenes are subjected to a very damp or humid atmosphere in storage, or shipped in extremely cold weather, moisture may condense on the surface of the pellets or particles upon exposure to the warmer or more humid atmosphere of work rooms. Dylene polystyrenes may be predried be-

* Technical Coordinator, Chemical Div., Koppers Co., Inc., Koppers Bldg., Pittsburgh 19, Pa.
[1] Trademark of Koppers Co., Inc.

ore molding by use of a hopper drier or by placing in an air-circulating oven in trays.

Purging routine: Both conventional and modified polystyrenes are readily purged from injection molding machines by the standard purging procedure.

Handling: None of the various types of polystyrene pellets available require specialized methods of handling. However, care should be taken when opening bags or drums of the material to prevent contamination.

Glass-Reinforced

BY E. Y. WOLFORD*

Fibertuff[1] polystyrene Type 1-56 is a recently improved type of glass-reinforced styrene with increased tensile and impact strengths and hardness. It is expressly intended for injection molding. Hence, it carries an appropriate quantity of an effective lubricant to promote ease of injection molding. It is not intended for compression molding or extrusion into pipe or sheet.

Fibertuff polystyrene Type 1-56 is furnished in pellets of approximately ⅛-in. dia. and ½-in. length. This has been found to be the optimum length since shorter glass fibers will not felt easily in the molded piece and will weaken it, whereas longer fibers suffer excessive breakage when passing through the gate of an injection mold. The glass fiber content is 35 ± 2½% by weight. Experience has indicated that a content of 65% improved heat-resistant type polystyrene lubricates the glass fibers sufficiently so that 40 mil-dia. pinhole gates can be used successfully. However, as two separate substances are present in heterogeneous mixture, the glass-reinforced styrene should not be confused with single-phase or homogeneous plastics such as nylon. Nor, since the glass increases both dielectric constant and dissipation factor, is it to be regarded as a material for electrical applications. The glass fiber is slightly hygroscopic and predrying of pellets is desirable but not necessary.

Compositions of lower glass fiber content and higher polystyrene content can be made by simply drum-tumbling the Fibertuff polystyrene pellets with normal or modified polystyrene pellets. The polystyrene pellets used for mixtures should always be of the improved heat-resistant type such as either Dylene[1] polystyrene Type 8 or Dylene modified polystyrene Type 800. Such admixtures, when injection molded, give uniform dilution of the glass fiber content; the fibers become poorly distributed only when reduced to less than 10% in content. Mixtures with modified polystyrene give very interesting impact-strength results. Point shocks appear to be resisted by the glass fibers. Gross shocks appear to be distributed throughout the molded structure by the modified polystyrene.

Dry coloring can also be accomplished by drum-tumbling, but, whenever the technique is used, the tumbling time should not exceed 15 minutes. Longer duration causes the glass fibers to fray out from the pellets, resulting in a tufted appearance in the surface of the molded pieces.

Fibertuff polystyrene pellets should be handled with gloves to prevent irritation and slow-healing dermatitis from glass fiber spicules. After molding, pieces can be touched with the bare hand without harm. In some cases, pieces have been dipped in aqueous destaticizer baths to remove surface spicules.

Molding conditions

Molds for Fibertuff polystyrene preferably should be hard-chrome-plated for abrasion resistance, although for molded pieces where surface appearance is unimportant, such plating can be ignored. Experience indicates that hard chrome plate may need renewal after 100,000 shots or less. In any case, flash chrome plate should be avoided. It merely promotes pitting by galvanic action. Hard chrome plate should be put over well-burnished copper and nickel under-coats to minimize pinholes.

The chief advantage of Fibertuff polystyrene, over and above enhanced mechanical strength, is its low mold shrinkage (ordinarily 0.001-0.0015 in. per in.) which allows molding to close tolerances. This factor, coupled with the rigidity, moisture resistance, and dimensional stability of the glass-reinforced styrene, makes the material especially useful for large-diameter, narrow width, close-tolerance reels, for spools and cage-type fan rotors, and other assemblies where the fit must be especially close and reliably permanent. For such pieces, the higher bulk factor (3.0 to 3.5) should be remembered when choosing the capacity of machine in which to run the mold. Maximum injection pressure is usually desirable to insure quickest fill of cavity. Cylinder temperatures between 450 and 600° F. have been found to give cycles of 120 to 30 seconds. Exposure to elevated temperatures for long periods should be avoided to prevent scorching. Of importance also is keeping the machine on cycle without interruption. However, pinhole gates have not been found to cause scorching of the polystyrene.

As there is no way to obtain bridging of glass fibers across weld interfaces, welds will have only the strength of normal polystyrene. Hence, welds should be minimized in design. In addition, holes should be frequently drilled by carbide-tipped tool rather than molded around cores. The same adhesives which serve for normal polystyrene are suitable with Fibertuff polystyrene, but such joints are not glass fiber reinforced.

Monsanto

BY ROBERT R. MOYER*

Recent changes in the Lustrex line include the addition of new polymers, the revision of formulations, and changes in nomenclature for several grades. The additions and changes reflect the rapid volume increase in extruded sheeting, the trend to automatic molding, and the continued expansion of packaging applications. The line includes impact, heat-resistant, and general-purpose grades.

General-purpose grade (un-

* Manager, Plastics Technical Service, Chemical Div., Koppers Co., Inc., Koppers Bldg., Pittsburgh, 19, Pa.
[1] Trademark of Koppers Co., Inc.

* Technical service manager, Styrene Molding Materials, Plastics Div., Monsanto Chemical Co., Springfield 2, Mass.

modified styrene): Current types are Hi-Flow 55, Hi-Flow 66, and Hi-Flow 77. Hi-Flow 66 is a new polymer of medium-flow grade. It is available as a colorant blend, crystal, and in transparent, translucent, and opaque colors. The nominal heat distortion is 176° F.

Hi-Flow 77 is the new nomenclature for Lustrex L. Fast setup rate, with relatively good flow and moldability, characterize this grade.

Hi-Flow 55 is used primarily as a colorant blend and pelleted crystal. It was originally developed for thin-wall and automatic molding requirements. Polymer molecular weight control results in a sharp softening point upon plastication and improves both the rate and uniformity of material heating in the injection cylinder. The product's nominal heat distortion of 165° F. was set to allow satisfactory use performance and to avoid the development of high residual strain due to rapid setup in thin-wall sections.

Impact-grade Lustrex (rubber-modified): To supplement LHA and Hi-Test 88, new polymers known as Hi-Test 88-A and Hi-Test 88-B have been added to the line. Hi-Test 88-A has improved toughness and higher elongation at yield. Currently it is available only as a colorant blend. Hi-Test 88-B has improved toughness, is a natural white and highly translucent base resin, and is available as a colorant blend, natural pellet, and in process colors.

Processing and physical property characteristics ascribed to Hi-Test 88 in the following paragraphs also apply to Hi-Test 88-A and Hi-Test 88-B.

Lustrex Hi-Test 88 is a tough, rubber-modified styrene for injection molding. It is available in a wide color range of pelleted translucents and opaques. A special natural (milky white) formulation also is available for dry coloring.

Elongation values are in the range of 20 to 25%, giving it 10 to 15 times the elongation of general-purpose styrene. Because of this improved elongation, less taper is required in the mold and in many cases shallow threads can be stripped. Impact values range from 50 to 500% higher than would be the impact values for general-purpose styrene.

In addition, Hi-Test 88 has excellent resistance to repeated flexing—a property which, when combined with its ultimate elongation and impact properties, gives the material an all-around toughness. In many cases it is this special feature of toughness that is required rather than any other individual property. These properties make Hi-Test 88 especially suitable for many applications.

Impact and elongation properties of all rubber-modified styrenes vary with the amount of orientation developed in the molded item. Maximum impact is obtained at lower injection cylinder temperatures, resulting in maximum orientation.

Excellent gloss can be obtained from Hi-Test 88 using conventional molds for styrene, with mold temperatures in the range of 140 to 160° F. Its mold shrinkage is comparable to that of general-purpose material. No special handling is required.

The heat distortion temperature of Hi-Test 88 has been reduced, compared to previous Monsanto impact formulations, to provide improved moldability. Its present heat distortion of 168 to 173° F. is sufficient for most applications. For special applications requiring improved heat distortion, Monsanto offers one other high-impact material, Lustrex LHR. Slightly higher cylinder and mold temperatures are required. The heat distortion range is 188 to 194° F.

Lustrex LHA, a medium-impact, rubber-modified grade, is especially suitable when additional toughness over general-purpose styrene is required. Its impact strength is about twice that of general-purpose material. Because of its added toughness, it is easily ejected when molded in thin-section and in deep draw parts with limited draft.

LHA is recommended for jobs formerly molded of general-purpose material to eliminate fracture on die ejection and in subsequent assembly operations to reduce breakage.

For die design, draw clearances of less than one-half degree taper per side have been used. The material can be molded readily at cylinder temperatures in excess of 600° F. If it is held too long at such temperatures, however, thermal breakdown occurs and the molded part loses impact strength. This condition is apparent when dark streaks appear on the surface of the part.

Hi-Heat 99 and Hi-Heat 99-A are offered as improved heat-resistant Lustrex compounds. Hi-Heat 99-A, a new polymer type, is particularly suited to extrusion and may be postoriented. This product is formulated for both injection and extrusion processing. Hi-Heat 99-A is available as crystal and Hi-Heat 99 as colorant blend, and in crystal and process colors. Subject to part design and the degree of residual strain, molded parts may withstand boiling water without deforming.

Formulations for this product, both for molding and extrusion, include colorant blend, crystal, transparent, translucent, and opaque colors. Machine heater settings, as related to general-purpose styrene requirements, should be 25 to 50° higher on all bands. Whenever possible, the front or nozzle band should be increased the minimum necessary to control mold-fill characteristics.

Maximum booster settings short of "pack" condition are preferred to higher injection pressure.

Cycolac Terpolymers

BY C. R. HOLT*

A multipolymer based on acrylonitrile, butadiene, and styrene, Cycolac is not a blend of resins, rubbers, or plasticizers but is a single material of uniform molecular structure, available in several different forms: white powder for calendering and solution work; natural-color (light translucent tan) pellets for extrusion and molding; pigmented pellets for extrusion and molding.

When injection molding Cycolac, it is preferable to predry the material before molding. Recommended procedures are as follows:

Type of equipment: Oven or

* Technical Service Mgr., Marbon Chemical Div., Borg-Warner Corp., 7165 Chicago Ave., Gary, Ind.

infra-red lamps; drying time, 1 hr.; drying temperature, 150 to 175° F.

Hopper driers are also advantageous for driving off surface moisture and for prewarming the resin. Drying temperature, when using the hopper dryer, is 200° F.

Equipment and molds

Equipment: In the injection molding of Cycolac, shot size should normally not exceed 50 to 60% of the capacity of the machine. As the part size increases, or as surface area becomes greater, the ratio of capacity to shot size should be increased and the gating made more generous.

Mold design: Molds for Cycolac should be constructed along conventional lines, bearing in mind the usual need for high pressures, generous runners, and large gates. Details such as internal ribs help the plastic to flow to the far ends of the cavities. Runners and mold surfaces should be highly polished for best flow of material and fine finish on the molded piece.

Runners: All multi-cavity molds should be designed with the shortest possible runners and with gates balanced for uniform fill of each cavity. Long major runners should be extended slightly beyond the furthest secondary runners to act as cold-slug traps ahead of the cavities. In some instances, a hot-runner-plate construction is helpful. Water-coring should be designed to keep runners as hot as possible.

Gating: Proper gating is very important for producing good-looking parts from Cycolac. Pinpoint gates are not recommended and restricted gates are normally satisfactory only for small parts of low surface area. In this type of product, a small gate should feed the plastic stream against a target wall or insert in the cavity to break up the flow pattern and prevent jetting. Excellent surface finish and appearance are obtained in this manner.

Gates must be rounded and streamlined, preferably widened at the cavity end and fed from deep runners so that hot resin flow is not hampered. Large gates should enter a heavy section of the part, not flush with a finished surface, to promote rapid fill and continuous steady flow from thick to thin areas. Gating on a finished surface may easily produce a blemish at the gate area.

Sprue-gated or center-gated parts which cannot take a cold-well will often show blush-rings or wave-marks around the gate. These should be run with a reverse-taper nozzle and/or with heater bands on the nozzle in order to prevent stiffening or chilling of the resin at the nozzle-end between shots. Disk or diaphragm gating into a small natural opening of the part is usually satisfactory, with the gate and cold-slug machined, punched, or bored out during finishing. Edge gates on thin sections cannot be opened up except by fanning out the gate along the edge or by deepening the gate over onto the surface of the section. Any deepening of the gate into a rib or structural part on the bottom side will help the flow. On parts of considerable surface area which must be edge-gated, the gate should be located on the longest side in order to provide the shortest possible flow across the face of the piece.

Multi-gating a large part will obtain rapid fill at lowest temperatures and pressures in the shortest cycles. This can be done into a large natural opening of the part (where an overly-large diaphragm gate is undesirable), or can be conventionally edge-gated. Principal deficiency of multi-gating is the creation of extra weld lines. With Cycolac, this is not too much of a problem, provided high mold temperatures are maintained and the weld areas adequately vented. All gates on a multi-gate part should be balanced to obtain uniform fill with the final weld taking place at the bottom edge or far edge.

Molds should be vented adequately in all areas to prevent gas burning, especially at welds.

Molding conditions

Molding technique: Molding of a new part should be started with low cylinder temperatures (380 to 400° F.), hot mold (170 to 180° F.), largest possible gate and nozzle, maximum pressure, and long cycle. A trial air-shot should be taken to inspect the plasticity, color, and appearance of the plasticated resin. The rope should be smooth, glossy, and nonporous, without lumps, particles, discoloration, contamination, or large blisters. After locking nozzle against bushing, temperatures should be gradually increased until complete fill is obtained (preferably not over 475° F. on the cylinder). Cycle time can then be reduced to the point of short-shots by first reducing injection time, then total time. Further reduction in cycle and in pressure can often be achieved at this point by enlarging the gate and runners. Inability to get full shots on a long cycle over a temperature range of 400 to 500° F., or the necessity of increasing molding temperatures more than 50 to 75° F. over that of the air-shot, very definitely indicate the need for larger gating.

Mold temperature: Mold temperature control is important for obtaining maximum gloss and a surface free of drag marks. Molds that are too cold will give short shots, strained parts, smear marks, dull finish, and weak welds. Too hot a mold will cause distortion of the part, sinking, and flashing, and will extend the freeze phase of the cycle excessively. The mold should be carried as hot as possible without involving these latter defects.

Purging routine: The press should be purged of Cycolac as soon as possible after a run is completed. When appreciable operational delays occur, the cylinder should be emptied of Cycolac. For purging, cylinder heats should be reduced to 400° F. or less and the cylinder purged at reduced pressure with a slow ram, using a viscous plastic such as acrylic or high-impact polystyrene. Temperatures should never be raised in purging Cycolac.

U. S. Rubber

BY WILLIAM J. COUGHLIN*

Kralastic[1] is a family of plastics in the category of acrylonitrile-butadiene-styrene polymers.

Hopper drying or oven drying is recommended when optimum gloss and appearance are desired. No special equipment is required. However, Kralastic is also being

* Naugatuck Chemical, Div., United States Rubber Co., Naugatuck, Conn.
[1] Trademark of United States Rubber Co.

TABLE I: Gating

Size of runners	
Range:	3/16 to 1/2 in.
Normal:	1/4 to 3/8 in.
Nozzle size	
Range:	1/8 to 1/2 in.
Normal:	3/16 to 5/16 in.
Gate size	
Range:	0.030 to 1.875 by 0.125 in.

molded successfully without drying. The granules can be dried sufficiently under conditions ranging from 4 to 6 hr. at 140° to 45 min. at 190° F.

In moldings where the injection pressure requirements are critical, external lubrication (36 gm. of zinc stearate/100 lb. Kralastic) is often required to reduce the pressure loss sustained in compacting the granules in the rear of the cylinder. The need for external lubrication must be considered on an individual job basis, with the definite molding machine and mold being considered.

Molding conditions

Kralastic can be injection molded on standard equipment, including machines equipped with preplasticators. Kralastic does not have a sudden critical melting point, nor does its consistency ever approach the state of water-like liquid. Kralastic can be molded over a wide temperature range (350 to 600° F.), with stock temperatures between 400 and 475° F. resulting in the best combination of physical properties and cycle times. Generally speaking, stock temperatures should be kept as low as possible, often determined by a visual inspection of the molded piece. However, there will be occasions when raising the stock temperature will result in improved knit lines and consistency of impact strength throughout the molded piece. Raising the stock temperature will slowly degrade the physical properties, but will not result in a sudden degradation.

Kralastic can be allowed to sit in the cylinder for a nominal length of time, and does not have to be purged during short shutdowns. Kralastic can be left in the cylinder indefinitely when the heat is turned off. Inspection of an air shot or a short shot will often help determine whether excessive conditions are being used. An air shot will indicate if the desired uniformity of consistency and color is being obtained, or whether the material is being overheated by excessive cylinder or nozzle temperatures. Abnormally rough leading edges in short shots usually means that the stock temperature is too low and that weld lines will not knit properly. Checking the runners may also be a help in detecting cold slugs or brittleness.

Critical flow situations, such as large, thin sections, unusually large shot size, large number of cavities, etc., may require cylinder temperatures of 500° F. or higher. If satisfactory parts are not obtained after gradually raising the stock temperature to the 500° F. range, maximum physical properties and minimum cycles will probably be obtained by: a) opening the gates and b) enlarging the runners. Of course, before such major changes are made, consideration should be given to the possibility of using a larger molding machine and/or preplasticators, and checking to see that all present equipment is working properly.

Maximum finish can be obtained by high mold temperatures (160 to 200° F.) and highly polished molds. The longer cycles introduced by high mold temperatures can often be reduced by the use of jigs, cooling baths or lower stock temperatures. When finish is not important, Kralastic can be run with cold water on the mold. Consideration should be given to the proper cooling of pins and core plugs. Warpage and cycle times can often be reduced by an air blast on the extremities of the mold that cannot be internally cooled.

Gates and runners

Molds for Kralastic have been designed with a wide variety of gate sizes (0.30 in. round to 1.875 by 0.125 in.). Large gates are generally recommended with the shot size, wall thickness, and the individual flow requirements the determining factors (see Table I, above). Restricted gating[2] has been used successfully but is not generally recommended. When short shots are obtained with restricted or pinpointed gating, the turbulence at the restriction point may require a lower, rather than increased, ram pressure. When positioning gates, consideration should be given to avoiding the placement of weld lines at locations where appearance or impact strength are critical.

Full-round runners (3/16 to 1/2 in.) are recommended; a trapezoidal design is the next most effective. Nozzle sizes from 1/8 to 1/2 in. have been used with 3/16 to 5/16 in. sizes the most common.

[2] 10 to 60% of wall thickness

INJECTION MOLDING VINYLS

BY G. G. ROTHMAN* and BILL WILLIAMS**

The emergence of a sound body of knowledge on the equipment and techniques necessary to mold vinyls successfully has made it possible for today's molders to take advantage of the unique properties of vinyl without encountering any of the thermal stability difficulties of past years. As a result, there has been a noticeable growth in the use of vinyl in the molding field.

Elastomeric vinyls, compounded from vinyl resin mixed with plasticizers, fillers, colors, lubricants, and light and heat stabilizers, are commonly available in the form of granules, cubes, or powders. The granules and cubes need a minimum of processing heat and working before molding. They have a significant heat history. The powders, on the other hand, have practically no heat history and are used for producing articles with more residual heat and light stability than those produced from granules or cubes. These powders, however, require more shear and working before injection molding in order to produce a satisfactory molded piece. Common practice when molding

* Development Engineer, B. F. Goodrich Chemical Co., Avon Lake, Ohio
** Senior Development Engineer, B. F. Goodrich Chemical Co., Avon Lake, Ohio.
References were prepared by the editors.

TABLE I: Injection molding characteristics of vinyls
(Recommended molding conditions for various section thicknesses)

Thickness of section:	*(Flexible vinyl) less than ⅛ in.*	*(Flexible vinyl) ⅛ to ¼ in.*	*(Rigid vinyl) over ¼ in.*
A. Temperatures, °F.			
1) rear cylinder	290-330	290-330	310-330
2) mid cylinder	300-340	300-340	320-340
3) forward cylinder	310-350	310-350	330-350
4) nozzle	320-360	320-360	340-360
5) mold face or mold coolant	110-140	110-140	140
6) melt leaving nozzle	320-360	320-360	350-370
B. Pressure exerted on material by ram, p.s.i.			
1) in standard cylinder	10,000-20,000	10,000-20,000	20,000-30,000
2) in injection cylinder of preplasticating machine	—	—	—
C. Timing			
1) total cycle (including mold-open time), sec.	30-60	30-120	60-240
2) ram forward time, sec.	3-10	4-20	30-60
D. Recommended gate dimensions (assuming cavity volumes of 1, 4, and 16 cu. in. for the three section-thickness classes)			
If round, diameter, mils	25-40	30-125	250-500
land length, mils	60	60-250	Small as possible
If rectangular, depth, mils	—	20	250
width, mils	—	60	500
land length, mils	—	60	Small as possible
E. Shrinkage allowance, mils/in.	Without annealing 10-30	Without annealing 10-30	Without annealing 4-6

the powders is to use oversize cylinders, dispersion nozzles, and often preheating of the powders to secure proper molded quality. Since it is more difficult to achieve high surface gloss when molding from powder, the technique is used more often in applications in which finish is not too important.

Rigid vinyl is the term applied to modified polyvinyl chloride and *unplasticized vinyl* refers to polyvinyl chloride which has been compounded only with stabilizer, lubricant, and color. The processing of unplasticized vinyl is not a simple matter and the incorporation of modifiers, e.g., rubbers, fillers, and often small amounts of plasticizer, to produce rigid vinyls, has been done in the interest of increasing the processing ease and/or impact resistance. In general, however, the inclusion of these modifiers results in lowering the chemical resistivity and the heat distortion temperature slightly. Unplasticized high-molecular-weight polyvinyl chloride is difficult to injection mold by conventional methods. Heat alone (below the thermal decomposition point) does not reduce the viscosity sufficiently for the material to flow easily. The flow curve of unplasticized and rigid vinyls seems to be slightly thixotropic in nature and the employment of shear and agitation immediately prior to the injection molding operation aids considerably in reducing the viscosity of the material and thus producing strain-free, homogeneous molded parts. As the Durometer hardness of vinyl compounds increases so do the injection molding temperatures and pressures.

Handling and equipment

Predrying: Since moisture absorption of vinyl is extremely low, predrying is not necessary.

Handling: Normally, no difficulties are encountered in molding vinyl as long as time and temperature recommendations are followed. However, considerable HCl gas can be evolved if the compound decomposes due to exposure to excessive temperatures for a period of time.

Special equipment: Normally, no special equipment is needed or used when molding vinyl. However, in the case of molding vinyl dry blends, a breaker plate nozzle may be used to aid in dispersing color pigments.

Cylinders: It is desirable to operate injection molding machines at less than rated capacity when running vinyls. A figure often used is about 75% of rated capacity, which includes sprue-bushing, runners, and cavities. Some molders have overcome this necessarily lowered capacity by replacing the standard cylinder with an extra-capacity cylinder. This method allows for a larger shot size and, if properly used, can actually result in longer runs before discoloration of stock is noticed. The temperatures used in an extra-capacity cylinder are normally lower than in a standard cylinder, since it takes the stock longer to travel through and therefore gives it more time to become plasticated.

Recommended materials of construction for cylinders and spreaders are carbon steel (may be used with very accurate

cylinder temperature control), chrome-plated steel, and Hastalloy C.

Plastication: The need for proper plastication is more important with vinyls than with many other molding materials. The rather low thermal conductivity of vinyls coupled with closeness of vinyl's flow temperature to its "thermal decomposition temperature" make necessary the use of improved plasticating methods.

The use of plasticating aids, such as small nozzles, restricted gating, longer cylinders, improved torpedoes, and preplasticating units, all contribute to easier molding of vinyl compounds. The screw preplasticating type of machine does an excellent job in plasticating PVC since the mechanical working and agitation of the material helps to distribute externally applied heat uniformly through the mass as well as to build up frictional heat. This results in lower cylinder temperature and, consequently, less exposure to the time-temperature cycle which is so important with vinyls. Restricted gating and small nozzles allow some reduction in cylinder temperatures since both methods generate frictional heat quickly by restricting flow and increasing velocity of flow.

Runners: In designing the mold, account should be taken of the fact that vinyls form a rather viscous melt instead of a fluid one. When the melt contacts the relatively cold surface of the mold, a vinyl skin is quickly formed in the sprue-bushing and runners. This effectively cuts down the runner area, and makes it necessary to increase the ram pressure in order to fill the cavity. With undersize runners, it may be very difficult, if not impossible, to fill the mold cavities completely. In practice, it has been found that full round runners, from 5/16 to 1/4 in. in diameter, are most satisfactory. The sprue-bushing itself may taper to 3/8 to 1/2 in. in diameter.

An important feature in runner design is the "liberal" use of cold-slugs or cold-wells to trap out the leading edge of chilled material flowing through the runners. If this material enters the mold cavity, it can cause many appearance defects, such as flow lines, weld lines, peel, etc. These cold-slugs should not only be placed at the end of the main runner, they should also be placed in the feed runners, just before the gates.

Gating: See Table I, p. 679, Sec. D. The subject of gating is a controversial one. Advantages and disadvantages can be found for all of the types which have been used. However, the simplest gate for molding vinyl is a pinpoint gate in the neighborhood of 30 mils in diameter. Its use generally promotes a better surface gloss on the molded articles because of frictional heat build-up, there is no degating problem, and there is less tendency for shrinkage of the molded piece at the gate section.

Normally, gates should be full round and as small in diameter as possible, but not so small as to create the need for excessive pressures to fill the mold cavity. For a larger molded piece, too small a gate would result in an inferior molding due to the creation of excessive mold-fill time.

Molding characteristics

See Table I, p. 679.

Special techniques: In the molding of vinyls, it is of prime importance to keep the stock moving through the cylinder. Consequently, during start-up, occasional purge shots should be taken so that material does not remain in the heated cylinder too long. On shutting down, the heaters should be turned off and the cylinder "flush-cooled" to below 250° F. before the operator leaves the machine.

If the melt in the cylinder is kept hot too long, it degrades. Top safe temperature for 20 min. exposure is 320 to 360° F.

Molding temperatures: Vinyls are truly thermoplastic, yet they actually are quite viscous at molding temperature. This temperature may be quite close to the so-called "thermal decomposition temperature" of the compound being used. Actually this is a function of both temperature and time. The maximum advisable molding temperature of a given vinyl compound varies according to the length of time that compound is to be held at that temperature. This is not a straight line function. While a vinyl compound may be held for hours at its optimum molding temperature, a temperature rise of as little as 10° F. above optimum may, in some cases, reduce the compound's stable time to a few minutes. This characteristic of vinyl compounds is the reason that flash-heating methods, such as restricted gating, are generally used. This time-temperature sensitivity varies over a wide range with commercially available molding compounds. In general, the harder the compound the less the spread between flow temperature and "decomposition temperature." Because of this, and the fact that vinyls have low heat conductivity, it becomes important to modify injection techniques in order to accomplish good results.

Purging routine: Purging becomes necessary when the compound starts to discolor. The compound being molded can be used for the purging, but a harder vinyl is generally more applicable. Polyethylene has also been used. When carbonaceous material breaks loose from the cylinder wall and enters the mold cavity, the cylinder should be pulled and manually cleaned.

References

For further information on elastomeric vinyls, see p. 164; on rigid vinyls, p. 171; on injection molding equipment, p. 893. For data on extrusion of vinyls see p. 728. Also consult the Subject Index and the Directory Index.

"Ceilings of light," MODERN PLASTICS *32*, 110 (Dec. 1954).

"Injection molding rigid vinyl." MODERN PLASTICS *31*, 113 (Dec. 1953).

"Restricted gating." by R. Bostwick and C. A. Joslin, MODERN PLASTICS *31*, 125 (Oct. 1953).

"Plastics for chemical engineering construction—unplasticized polyvinyl chloride," by George S. Laaff, Chem. Eng. Progress *50*, No. 6, 275-282 (June 1954).

"Unplasticized polyvinyl chloride," by J. L. Huscher, Chem. Eng. (Nov. 1952).

Compression and Transfer Molding

IN THIS SECTION

Alkyds 683
Melamine 686
Phenolics 698
Urea Formaldehyde 690
Tetrafluoroethylene 694

For a clearer understanding of the recommendations contained in the individual articles that follow on the compression and transfer molding of specific plastics materials, this introductory section covering basic over-all techniques has been prepared.

INTRODUCTION TO COMPRESSION MOLDING

BY CHARLES E. MARKHOFF*

Since thermosetting molding materials are not fully reacted when they reach the molder, the application of heat and pressure in the molding operation serves to complete the polymerization reaction. Compression, plunger, or transfer molding are the methods most commonly used to soften and to shape thermosetting molding materials, as well as to cure these materials.

In compression molding, the material, either loose or preformed, is placed directly into the open mold. As the mold is slowly closed, the material becomes plastic and is forced into all parts of the mold. The mold is kept closed for the time required to cure the part.

Types of molds

There are four general types of compression molds: 1) flash; 2) positive; 3) semi-positive; and 4) landed-positive. (See Figs. 1 and 2, right, and Figs. 3 and 4, p. 682.) The subcavity type, Fig. 5, p. 682, is a variation of type 4.

The truly positive-type mold provides a tight fit between the force and cavity. Almost no material escapes during molding and full pressure is maintained on the material. Since excess material cannot escape, this design is not widely used. Instead, the semi-positive and landed-positive variations find greater acceptance. These designs permit the use of multiple-cavity molds since the excess material is free to escape. However, the two halves of the mold telescope to some degree; this telescoping maintains pressure on the material during the last of the closing cycle. Consequently, these designs are usually modified with sprues or flutes in the telescoping forces to permit easier escape of excess material.

Flash molds permit the escape of material between the cut-off lands as the mold closes. The pressure on the material is less with this type of mold. A greater excess of material must be used; slow press closing is recommended, as is also the use of material having the proper plasticity. The initial cost is also less.

Application possibilities

Compression molding is especially applicable to the molding of large-area, deep-draw parts. Radio and television cabinets, instrument housings, trays, and similiar large parts are molded by this method. The size of the article which can be molded is limited only by the tonnage and size of the available press equipment. In addition to large articles, compression molding is used to good advantage in the large-scale production of simply designed articles such as buttons, closures, tableware, radio tube bases, electrical wiring devices, and similar products. On these smaller parts, multiple-cavity molds and/or automatic compression molding techniques have made important production savings possible.

Compression molding is not normally recommended for intricately designed articles containing undercuts, side draws, small holes, and inserts. The flow of the material under high pressure may distort or break pins and dislodge inserts. Such parts are usually made by transfer or plunger molding. However, the use of electronically preheated powder in compression molding appears to be overcoming some of these disadvantages. Less pressure is required to mold an article using preheated powder than using a preheated preform. This may broaden the application of compression molding.

Transfer molding

Transfer or plunger molding is the term applied to the process of molding articles by injecting the

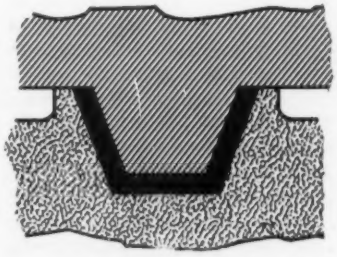


Fig. 1: Compression mold of the flash type

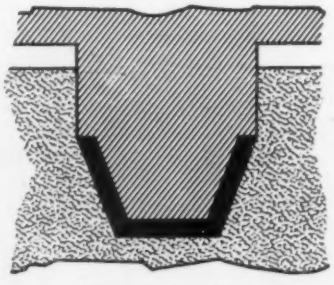


Fig. 2: Fully-positive type compression mold

* The Borden Co., Chemical Div., 5000 Summerdale Ave., Philadelphia 24, Pa.

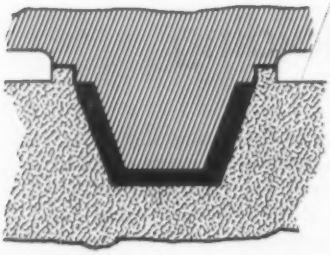


Fig. 3: Compression mold of the semi-positive type

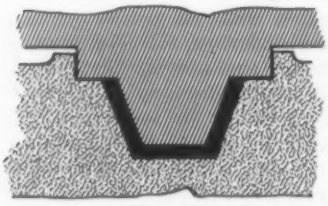


Fig. 4: Landed compression mold of the positive type

molding material into the closed hot mold in a hot plastic state from an auxiliary chamber. There are two methods which fall under this classification: transfer or pot-type transfer and plunger or auxiliary ram transfer.

In both methods, the material is forced from an auxiliary chamber to the closed mold where it is kept until the part has cured. Pot-type transfer has been largely replaced by the plunger method of molding. Plunger molding has several advantages to offer over compression molding. As mentioned previously, the filling of intricate molds or molds with long core pins or inserts is better accomplished with plunger molding. In addition, shorter molding cycles are possible with plunger molding. The loading time is shorter with plunger molding since fewer and larger preforms are used. These can be preheated more rapidly and efficiently and handling time is reduced. Shorter curing times are possible, particularly in thick sections. This is true because material is heated as it is forced through the gate. Volatiles are also permitted to escape through vents and clearances around movable pins.

The initial mold cost of a plunger mold is lower since deep wells are unnecessary and mold sections can be thinner than with compression molds. Easier finishing is also possible with plunger-molded articles since the flash should be quite thin or nonexistent. Gates can usually be made sufficiently small and so located that the removal is easy and inexpensive.

There are a number of disadvantages of plunger molding when compared with compression molding. The material left in the pot and runners is completely reacted and must be discarded. This loss is unavoidable and can represent a sizable percentage of the weight of the pieces molded. Another disadvantage is loss of mechanical strength with improved-impact materials containing fibrous fillers.

Plunger molds

Most plunger molds have been designed with the following conditions in mind: 1) minimum plunger pressure, permitting larger molding areas with the same clamping force, allowing 15% safety factor for adequate clamping; 2) smallest runners possible to prevent waste; and 3) smallest gates possible to minimize finishing operations and provide faster curing cycles.

In addition, individual hardened steel cavities and forces should be mounted in the chase and force plates. Runners and gates also should be hardened. A hardened-steel block insert for the gates is especially recommended. The center of the block at the bottom of the pressure chamber should also be a hardened-steel insert. All land areas should be ground and polished for maximum contact so that the material will not flash from the cavities and runners when the mold is closed.

Circular or square runners permit the use of lower plunger pressures. Runners should be as short as possible to avoid precuring the material. Larger diameter runners and gates are recommended in molding impact materials in order to preserve the impact strength. Larger diameter runners are also recommended for heat-resistant materials since the heat transfer is faster with a mineral-filled material than with a general-purpose material.

The gates should be located so that the removal may be accomplished easily by simple finishing operation. Generally, the cavity should be gated into a heavy section. Care should be taken not to gate the cavity directly opposite a mold pin or other protrusion. Such a design could cause flow lines and weld lines which mar the appearance and may decrease physical strengths. If possible, the gates should be located so that the entering stream of material does not directly strike a polished mold surface.

Proper venting is essential to successful plunger molding. Vents permit quick escape of air and gas. Vents should be located at the point which fills out last. This is usually, but not necessarily, the point farthest from the gate. Proper venting will permit rapid filling of the mold, give shortest cycles and cures and help avoid sticking and staining problems. Vents 2 to 5 mils in depth and $\frac{1}{16}$ to $\frac{1}{8}$ in. wide are common.

Miscellaneous factors

The success of a molding operation is not solely dependent upon the method chosen. Other important factors are: the proper selection of material; whether or

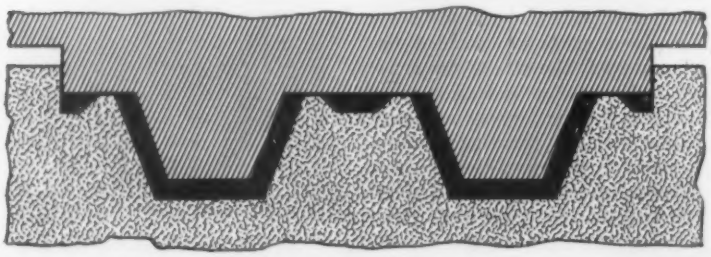


Fig. 5: Sub-cavity type compression mold

not to preform; type of preheating; whether to use an automatic operation; mold design; and, last but not least, the design of the article to be molded.

Good mold design must start with the design of the piece. With the emphasis being placed on automatic molding operations, this principle is more important today than ever before. In order for a molding operation to be completely automatic, the part must mold and be ejected without trouble every cycle. To achieve this type of operation, one must begin with the proper design of the part and follow through with the proper design of the mold.

COMPRESSION MOLDING ALKYDS

BY J. J. MOYLAN*

Continuing research on alkyd molding compounds has resulted in the development of many types since their introduction more than ten years ago. While the general characteristics of fast cure and low pressure requirements are common to all of these compounds, they may be divided into three different groups corresponding to physical form before molding.

Granular materials: The physical form of materials in this group is that of a free-flowing powder. Thus, these materials readily lend themselves to conventional molding practices such as volumetric loading, preforming, and high-speed automatic operations. These materials have found extensive use as high-grade electrical insulation, especially in the electronics field. Typical applications are television tuner segments, electronic tube bases and sockets, resistor housings, etc.

Putty materials: This group contains materials which are furnished in soft, putty-like sheets. They are characterized by very low pressure requirements (less than 800 p.s.i.) and find use in molding around delicate inserts and in special loading problems. The molder of these types customarily extrudes the material into a ribbon of a specific size which is then cut into preforms before molding. Putty materials have found widespread use in encasing electronic components such as capacitors, resistors, small coils, etc.

Reinforced alkyd materials: Among recent additions to the alkyd family are materials which combine the molding characteristics of polyester resins with the reinforcing action of fibrous glass fillers to attain very high strength. These materials have found widespread use in such applications as insulating brackets and bases, rocker rings, circuit breakers, heavy-duty coil forms, and similar applications where high strength and good electrical characteristics are important. In many cases they have replaced assemblies of metal and insulating materials. Recent developments in materials of this type include a compound having markedly superior handling characteristics. In addition, alkyd materials having small percentages of glass fibers, intermediate in strength properties and cost, are now available, as well as materials containing sisal and other fibers for reinforcements.

Within each of the three groups of alkyd materials described above, several distinct types are available. For example, some types are self-extinguishing, some have approval under military specifications, some have improved high-humidity performance. The manufacturers' literature on these materials should be consulted before selecting a material for a specific application.

Presses and equipment

Although full realization of the advantages of molding alkyds is best attained through the use of high-speed, lightweight equipment, nearly all modern compression presses are suitable for use with these materials. Some presses may be encountered, however, which are so slow that it is necessary to speed the ram travel by use of a high-volume pump or to decrease the amount of travel by mounting the mold on blocks to reduce daylight. Because of the low-pressure molding characteristics of alkyds, the high-pressure line may sometimes be cut out completely and only the low-pressure side of the system used. In general, not more than 4 sec. should elapse before charging the mold and applying full pressure in the case of granular and putty types, or 8 sec. in the case of fibrous glass-reinforced material.

In selecting a press to operate a specific mold for alkyds, the following rule should prove useful for average draws, the press should furnish about 1500 p.s.i. over the projected area of the cavity and lands for molding granular alkyds; about 800 p.s.i. for alkyd putty; and about 2000 p.s.i. for glass-reinforced alkyd.

Marked savings in labor, maintenance, floor space, power costs, and depreciation are possible through the use of presses specifically designed for use with alkyd materials. Detailed information and specifications are available directly from the manufacturers.

Design and construction

Alkyd parts are in successful production in positive, semi-positive, and flash molds. In general, the semi-positive and positive types are recommended to obtain uniformly dense parts with lowest shrinkage. Flash types, since they rely on the back pressure of the material for density, do not usually produce parts of maximum density due to the soft flow characteristics of alkyd materials. However, flash molds are frequently used with alkyd putty because of its low bulk factor. In any case, the use of polished, hardened, chrome-plated steel molds is recommended.

Positive and semi-positive molds should be designed for enough freedom to allow escape of material to prevent over-pressuring. Punch clearances on positive molds of the order of 0.004 to 0.005 in. are generally recommended for the granular and putty types. Slightly greater clearances are customarily used for glass-reinforced materials. Ex-

*Glendale-Plaskon Laboratory, Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

References were prepared by the editors.

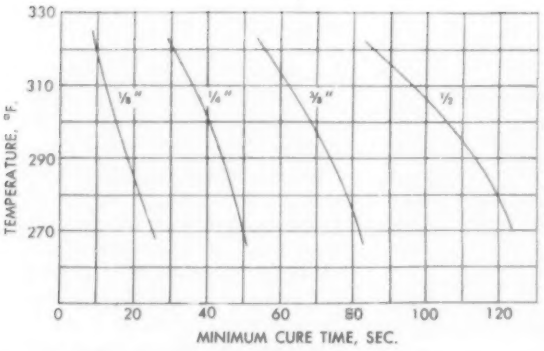


Fig. 1: Minimum cure time vs. temperature for various thicknesses of alkyd granular and putty materials

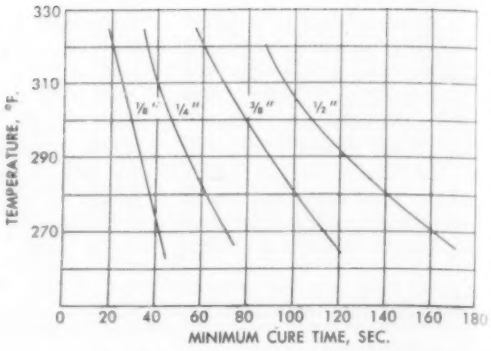


Fig. 2: Minimum cure time vs. temperature for various thicknesses of reinforced alkyd material

cessive clearances are to be avoided since they reduce the effective molding pressure on the material, and thereby cause a reduction in strength.

An allowance of 0.004 to 0.007 in./in. should be allowed for shrinkage from cold mold dimensions in the case of compression molded parts; transfer or plunger molding will result in somewhat higher shrinkages. This shrinkage is dependent upon mold design, shape of the piece, and in some cases on the pressure and temperature of the operation. It is highly reproducible on a given part. There is no measurable after-shrinkage on alkyd parts over an extended period since there are no residual volatiles or continuing chemical reactions involved after molding.

The use of transfer- or plunger-type molds is not generally recommended for molding putty or granular alkyd. In many such molds the plastic phase is too short to permit the material to complete its travel through the gates and runners before cure sets in. Precuring, even when it does not preclude complete filling of a mold cavity, can result in porosity, uneven density, and incomplete fusion. Such conditions obviously lead to loss of mechanical and electrical properties and to sharp deterioration in water resistance. In some cases, defects occurring in a transfer molded piece may be concealed to the eye but will cause trouble in testing or in service.

On the other hand, there are applications successfully in production on transfer molds in granular material. These transfer molds meet the following design requirements:

1) relatively small pieces to be molded; 2) cavities grouped very closely to the transfer pot; and 3) very wide open runners and liberal gating.

It has also been noted that parts molded in transfer cavities gated at two locations show poor mechanical strength, especially at the weld line. In general, parts molded by either straight transfer or plunger methods are lower in mechanical strength and lower in electrical insulating properties than similar parts molded by compression molding.

Reinforced alkyd may be transfer molded but the strength of such pieces is somewhat lower than that of compression molded pieces, the magnitude being almost entirely dependent on the size of the gates and the number of times the material changes direction before entering the cavity. Since these changes are dependent upon design, pieces will have to be tested individually in order to determine the suitability of the material for specific applications.

Multiple gates should normally be avoided because of the knitting effects between gates. An exception to this is the transfer molding of circular pieces for which knitting must occur to fill the cavity. In such cases, continuous circular gating is recommended. Better strengths are usually achieved by gating at the end of the piece rather than in the middle. When shrinkage tolerances are critical, it is recommended that both transfer ram and clamping pressures be sufficient to insure dense pieces.

Molds

To date, most alkyd molding has been done in molds utilizing conventional mold steels hardened by standard heat-treating methods. Other metals have been used for experimental and short-run molds. Some production molds have been chrome-plated while others are only highly polished, depending upon the preferences of the mold designer. The fact that the alkyds can be molded at low pressures has presented the possibility of using other than steel molds.

Alkyds, being mineral-filled materials, are somewhat more abrasive than general-purpose ureas or phenolics, and somewhat greater mold wear may be anticipated. Because of lower molding pressure and the greater plasticity of the alkyds, mold wear is not as great as it is with mineral-filled phenolics. The use of minimum pressures that permit satisfactory molding tends to reduce the effects of mold wear.

The usual precautions on design of pieces for thermoset molding should be followed. Particular attention should be paid to the use of flowing curves and generous radii rather than sharp knife edges. Sections should not be designed in any case for less than 1/16-in. thickness, and projections and ridges should be designed with generous allowances for material.

The fast-curing characteristics of alkyd molding compounds

should, of course, be taken into consideration when designing the number of cavities for a given production mold. The high production rate per cavity of these materials represents a definite savings in tooling cost.

Special considerations

Common characteristics of all glass-reinforced polyester molding compounds should be considered in designing parts. Some of these characteristics are: 1) a tendency to trap air in unvented draws; 2) a tendency toward internal porosity and internal cracking in heavy sections; 3) a tendency to crack or show poor strength when fiber alignment occurs due to flow obstruction; 4) a tendency to have relatively poor strength in thin sections; 5) a tendency to show porosity or poor end-fill on long, restricted flows; and 6) a tendency to show relatively poor dielectric strength in thin sections or in areas where fiber alignment may be normal to the conducting surfaces.

Although solutions to these difficulties may not always be possible through design alone, it may frequently be possible to avoid trouble by their careful consideration at the design stage.

Air entrapment in blind draws may frequently be overcome by venting at the top with a working pin. Sharp corners and square edges at the top of draws should be avoided in favor of radii whenever possible. It may also be possible to design the part so that the place where air may be trapped is isolated to a small area where it may be easily vented.

Although the internal porosity or internal cracking frequently encountered in sections heavier than ¼ in. may not interfere with the function of most parts, it may become a prime consideration if the section must be drilled or tapped or if electrical contacts carrying high voltage are to be molded in. In such cases, heavy sections should be avoided.

When the material flows around obstructions such as core pins, a certain amount of fiber alignment results. If the flow continues for a short distance beyond such points, the fibers tend to regain their random orientation and a good knit results. However, if the obstruction is near the end of the flow such as the extreme edge or top of the part, the fiber alignment may result in poor knitting or cracking. For this reason, location of core pins at extreme edges is to be avoided wherever possible. Otherwise, it may be necessary to use a vent or bleeder to obtain flow for a sufficient distance past the obstruction to accomplish good knitting.

Although sections thinner than 0.015 in. may be successfully molded, the strength characteristics are quite low due to fiber alignment and fiber breakage. In general, sections greater than 0.040 in. are to be recommended.

Because of the fast-curing characteristics of the material, it may be difficult to fill parts having long flows, especially if the flow is restricted by thin sections, core pins, inserts, etc. Although loading techniques may overcome this, it is recommended that long draws be accompanied by generous sections.

Fibrous glass-reinforced materials may show good dielectric strength by standard test methods in which electrode configuration and specimen shape and thickness are carefully specified. However, in actual applications in which voltage stresses may be concentrated at sharp corners and in which thinner sections may contain fiber-resin interfaces or other nonhomogeneous areas extending from surface to surface, glass-reinforced materials may show much lower dielectric strength.

Preheating and preforming

Although preheating of the granular or putty type is seldom necessary or desirable, reinforced alkyds are frequently preheated before weighing the mold charge to improve their handling characteristics. This is usually done in an air-circulating oven maintained at 130 to 140° F. for a period of 10 to 15 minutes.

It is also possible to use electronic preheating on reinforced alkyd. In this case the bulk factor is customarily reduced by mechanical or manual compression.

Because of the low bulk factor of the granular alkyds (approximately 2:1), it is seldom necessary to preform these materials. However, they will preform with ease on conventional equipment when necessary. The preforming pressure is much less than that required for phenolic or urea materials. To avoid excessively dense preforms, it is customary to reduce the pressure of the preforming machines to about one-fourth the amount used for preforming the conventional thermosetting materials.

As previously mentioned, the putty materials are usually preformed by extrusion. Extruders of both the screw type and the plunger type are in common use on these materials. An alternate method is to roll the putty into sheets of the desired thickness, from which ribbons or slugs may be cut and used as preforms.

Because of the relatively high bulk factor of the reinforced types, some preforming of the material is usually necessary. This is often done by simple hand compression after warming to 130 or 140° F. as previously mentioned. Mechanical preforming methods are sometimes used and machines have recently been developed to extrude material of this type into continuous ribbons or ropes, from which preforms may be cut.

In reinforced alkyds, the shape of the preforms will have a definite effect on the flow characteristics of the material within the mold. For this reason, some experimenting with preform shapes may be necessary. In general, the preform should approximate the shape of the mold but should be somewhat smaller to insure some flow of material. Multiple preforms are to be avoided because weak sections may be encountered at the interfaces or knit lines.

Molding techniques

The resin characteristics of alkyd molding compounds are such that the material goes through the very low viscosity phase momentarily when heat and pressure are applied. This low viscosity phase makes possible the complete filling of the mold at pressures much lower than required for other thermosets.

This phase is followed by a very

rapid, exothermic reaction which develops heat in excess of the mold temperature and which is responsible for the rapid cure of the material.

Since the reaction is a cross-linking polymerization, no products are given off in gaseous form; therefore, no breathing or holding is necessary.

Because the heat resistance of the material is relatively high, it is possible to leave parts in the mold at recommended molding temperatures for extended periods without risk of burning or overcure.

The most common molding difficulties experienced with alkyd molding techniques are precure of the material or use of excessively high molding pressures, or a combination of both.

Molding temperatures

The range of recommended molding temperatures extends from 270 to 330° F. In the majority of cases, mold temperatures in the range 300 to 320° F. will be most suitable. (See Figs. 1 and 2, p. 684.) In extreme cases, where long thin draws or slow presses are involved, temperatures as low as 250° F. have been used. However, the use of such low temperatures may tend to promote sticking, especially on mold surfaces which are not chrome-plated.

Under ordinary conditions, alkyd materials have good release characteristics and no lubrication is necessary to insure ejection from the mold. Hardened, chrome-plated steel surfaces are recommended. When sticking is encountered, it is usually due to too much pressure or insufficient temperature. When a mold has been running phenolic material, it is recommended that it be cleaned by running a few charges of urea or melamine before the alkyd is introduced, since the presence of phenolic resin, even in minute quantities, inhibits the cure of alkyd. Before returning a mold to the use of phenolic materials after running on alkyd, the same procedure should be followed.

In the transfer or plunger molding of reinforced alkyds, plunger pressures are largely dependent upon gate size. In general, a pressure which will bring the plunger home in about 7 sec. is recommended. However, successful cycles are in use with plunger times in the range from 3 to 12 seconds. Longer times are apt to cause precuring in the transfer pot or in the runners and gates.

Inserts

Because of the fact that alkyd materials have no after-shrinkage, inserts must be provided with generous knurls or undercuts to insure good gripping. Because of the soft-flow, low-pressure characteristics of alkyds, especially in putty form, many jobs involving delicate inserts have been run in these materials which could not be run successfully in any other thermosetting material.

Storage

An understanding of proper storage conditions for alkyd is perhaps more important than in the case of other plastics. The alkyd compounds are by nature more reactive than other thermosets and are, therefore, more sensitive to handling and storage conditions. Hence special care should be taken to follow the manufacturers' specific storage recommendations.

References

Consult Directory Index and Subject Index for additional information on alkyds. See also the chapter on Polyester (Alkyd) Resins, p. 140.

"Alkyd control chassis eliminates 140 assembly steps," MODERN PLASTICS *31*, 98 (Nov. 1953).

"Alkyd plugs," MODERN PLASTICS *30*, 183 (April 1953).

"An alkyd with muscles," MODERN PLASTICS *29*, 84 (February 1952).

"Case histories of alkyd molding," by DeVore, H. W., and Murray, H. E., MODERN PLASTICS *28*, 88 (April 1951).

"Molding the 'specialized' plastics," MODERN PLASTICS *28*, 85 (Dec. 1950).

"Alkyd molding materials," by Redfarn, C. A., Brit. Plastics *27*, 131-33 (April 1954).

"Glass-reinforced alkyd plastics," by Bigelow, M. H., and Nowicki, P. E., Electrical Manuf. *49*, 110-13 (April 1952).

COMPRESSION MOLDING MELAMINE FORMALDEHYDE

BY H. J. WEST*

Properties of melamine formaldehyde molded parts vary according to the type of filler employed, but the moldings are generally highly resistant to water, mild acids, and alkalies and possess excellent dielectric strength and arc resistance. The alpha-cellulose-filled grades offer unlimited color, abrasion resistance, and durability. By the use of special fillers such as chopped cotton fabric, fibrous glass, or asbestos, specific properties may be emphasized for many important industrial applications.

Storage and handling

Storage under suitable conditions is of considerable importance in maintaining the as-shipped flow characteristics of melamine molding materials.

It is good practice to store at temperatures below 70° F. although the material should be allowed to warm up to at least 70° F. before charging the mold or preform machine. Attempting to preform too-cold material may cause unsatisfactory preform hardness.

Preforming

All standard commercial preforming machines should handle melamine granular molding material satisfactorily.

Preforming pressures range from 10,000 to 40,000 p.s.i., and depend on the size of the pill, the grade of material, the temperature of the material and speed of pressing. Pills must be hard enough to hold together during handling, but if too hard they may give poor molded parts. Pill-break marks may appear on articles molded from pills which are too hard.

The importance of temperature of the material in preforming is

* Plastics and Resins Div., American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.
References were prepared by the editors.

illustrated in Fig. 1, right. The preforms will be too soft if the temperature of the material is too low. During the winter months the molding compound may be exposed during transit or in unheated storage to prolonged subroom temperatures. To bring the material to preforming temperature, it may be necessary to store it in a heated area for a day or more. Best results are obtained when the temperature of the material is 70 to 85° F.

When pills are made from powder or bulk material with hand dies, they are harder in comparison with pills made by automatic machines because of longer dwell under pressure. For this reason, large pills are sometimes hand pressed under reduced pressure. The longer dwell has an additional advantage in allowing more complete escape of entrapped air, giving a more durable pill.

In general, dies used for preforming melamine molding compounds should be of the highest quality steel hardened to 56 on the Rockwell C scale, polished to a high commercial finish, and hard chrome-plated. A taper of 0.002 in./in. on the diameter (0.001 in./in./side) is desirable to ease ejection and prolong the life of the dies. Figure 2, p. 688, shows satisfactory clearance ranges for punch and die using granular molding material.

Preheating

Melamine molding compounds can usually be preheated by any accepted method, but high-frequency preheating is most common and generally gives the best results. Preheating is strongly recommended to obtain the shortest molding cycles and to develop optimum properties and best appearance.

High-frequency preheating is most effective with preforms but granular material can be so heated if placed to a uniform depth in a shallow glass or polyethylene container. Variations in depth will result in nonuniform temperature in the charge.

Rag-filled materials can be shaped by hand and placed between the electrodes.

There is a normal variation in the thickness of preforms which cannot be avoided. If preforms of different thicknesses are placed side by side in an electronic preheater, they will not heat uniformly. One way to avoid this is to stack the pills during preheating. The ideal situation is to employ square or rectangular preforms which can be placed on edge, thereby eliminating the thickness variation. This is particularly advantageous where multiple pills are required.

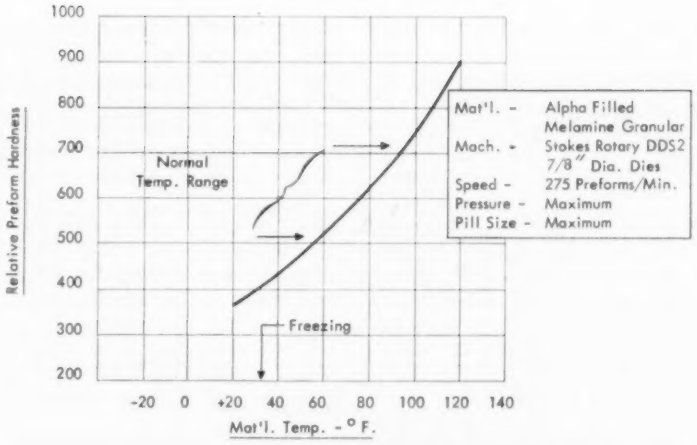


Fig. 1: Preform hardness vs. material temperature

The temperature range usually suggested for preheated melamine compounds is 220 to 250° F. The preform has usually reached a satisfactory temperature when it begins to swell and a small fracture appears at the periphery. Some large moldings are made with granular load preheated to 200° F. in a polyethylene or glass container.

Rotary-can preheating is usually less efficient than the high-frequency method but good results can be obtained if proper care is exercised. The containers must be carefully cleaned between heats to prevent overheated material from contaminating the subsequent charges.

Molding temperature and pressures

Melamine formaldehyde molding materials, like other thermosetting materials, soften and develop plastic flow under the heat and pressure of the molding operation. As the molding progresses, the heat induces a chemical condensation reaction and the material cures to a rigid, infusible molded part. The mold must be filled out with the material at maximum density before cure is allowed to develop. Time must also be allowed for moisture to escape before the material is fully cured.

Care must be exercised to insure that the material in the mold becomes uniformly heated throughout before closing the mold. Material in close contact with the walls of the mold may become too plastic before the rest of the charge is softened. Then, as the mold is closed, the soft material can be forced out before the remainder is properly densified. It is possible for the material adjacent to the wall to cure before full pressure is applied, resulting in a molding with a weak, poorly densified shell.

If moldings have adjacent sections of different thicknesses, too high a molding temperature may give both overcured thin sections and undercured heavy sections.

Because of the behavior of the material during molding, the temperature *vs.* cure curve for each grade of material must be considered in relation to the size and design of the part in determining the optimum molding conditions.

The rate of cure for any specific material is solely a function of temperature. Actual cure times may range from a fraction of a minute at 330 to 340° F. for molding buttons, to 3 to 5 min. for heavy moldings with mineral-

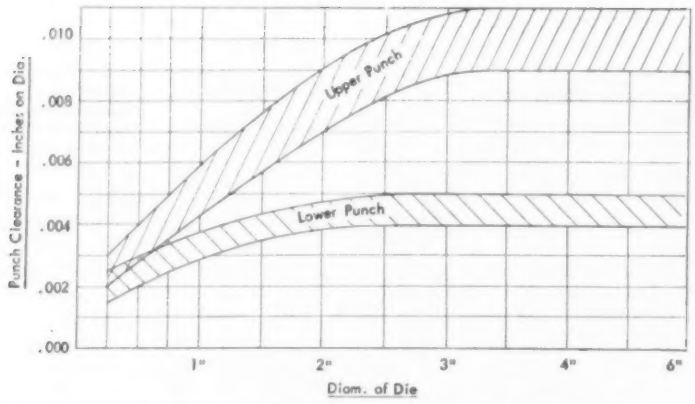


Fig. 2: Recommended punch and die clearances for granular melamine material

filled melamine molding material. Typical cure times for some different grades of commercial materials are shown in Table I, below.

Melamine resins are considerably less critical than urea resins in regard to temperature and duration of cure, resembling the phenolics more closely in moldability. It is relatively easy to impair the properties of ureas by overcure or "burning," whereas, because of much better heat resistance, melamine resins are much less sensitive to overcure.

Buttons and closures can be molded at high temperatures with fast cycles since the flow involved is of minor degree and the small cavity charge quickly reaches mold temperature. Large pieces requiring a high degree of flow in the mold and the transfer of heat through a mass of material require a longer cycle at lower temperature.

Pressure depends on several factors which include the size of the part, the depth of draw, whether or not the material is preheated, and the flow or plasticity of the material being molded. Typical compression molding pressures range from 1500 to 5000 p.s.i. Transfer molding operations require pressures from 4000 to 20,000 p.s.i.

Flow characteristics

The degree of flow or plasticity of the molding material under molding conditions is an extremely important factor. It has a bearing upon the kind of molding that can be made, the quality and properties of the molded p[art] and the type of mold that can [be] used. Flow must continue u[ntil] the mold is completely filled [out] under maximum pressure. Sm[all] parts of simple design are b[est] molded with stiff material. La[rge] objects require the use of easy-to-flow soft grades that will fill out the mold before the material sets. Fast-curing stiff grades can not be transfer molded since set may occur before the material is completely transferred.

The alpha-cellulose-filled melamine formaldehyde molding materials are generally supplied in varying grades of plasticity, designated as soft, medium, or hard. The softer grades are primarily designed for use in transfer molding, high-speed plunger molding, or compression molding of relatively large parts. The stiffest grades are used for molding buttons and other small parts.

Impact materials are normally available in a general-purpose plasticity.

The industrial grades of melamine formaldehyde molding materials—comprising wood-flour-filled material and mineral-filled material—are often used for molding parts for the electrical industries. Many industrial parts are of intricate design with metal inserts and are usually transfer molded.

TABLE I: Typical cure times at various temperatures for melamine molding materials[1]

Grade	*Temperature*	*Cure Time*	
	°F.	*⅛-in. disk*	*¼-in. disk*
Alpha cellulose	310	90 sec.	2 min. 15 sec.
filled[2]	320	60 sec.	3 min. 00 sec.
	340	50 sec.	1 min. 50 sec.
Cotton fabric	300	3 min. 30 sec.	4 min. 15 sec.
filled[2]	320	2 min. 45 sec.	3 min. 30 sec.
	340	2 min. 00 sec.	3 min. 00 sec.
Modified melamine—	310	2 min. 00 sec.	3 min. 00 sec.
alpha cellulose	320	1 min. 45 sec.	2 min. 45 sec.
filled[3]	330	1 min. 30 sec.	2 min. 30 sec.
Mineral filled[3]	310	1 min. 45 sec.	2 min. 30 sec.
	320	1 min. 30 sec.	2 min. 15 sec.
	330	1 min. 00 sec.	2 min. 00 sec.
Glass filled	300	1 min. 05 sec.	—

[1] Data are based on 4-in. disks of ⅛- and ¼-in. thickness compression molded of cold granular materials. [2] Cure to acid boil test. [3] Cure to appearance.

Decorative effects

Beautiful molded-in decorative effects can now be developed in alpha-filled melamine moldings by the use of resin-impregnated alpha-paper foils which have been printed with a decorative design. In using these foils, the compression molding operation is conducted in the usual manner and continued until the part is cured sufficiently to hold together well. The mold is then opened and the foil inserted with its printed side down. The mold is then slowly reclosed, full pressure applied, and held for final cure.

At the present time, most foils are flat sheets so that draw possibilities are limited.

Shrinkage

Shrinkage is an unavoidable phenomenon that occurs in varying degrees in the molding or

curing of all thermosetting materials. It occurs in two stages—during the actual molding operation and during the subsequent aging of the molded part in service. The two stages are known as mold shrinkage and after-shrinkage. The latter is mainly caused by continued loss of moisture or drying out of the part and continues until the moisture content is in equilibrium with the ambient relative humidity. Even then, dimensional changes may still take place through absorption of moisture under cool damp conditions followed by drying under warm, low-humidity conditions.

Typical shrinkage ranges for melamine molding materials are shown in Fig. 3, right. The values shown are given in mils/in. based on a 4 by ⅛-in. molded disk.

The degree of shrinkage varies with the following five factors:

1) *Type of material:* Shrinkage varies widely according to the grade of melamine formaldehyde molding material. The alpha-cellulose-filled unmodified melamine materials show the highest mold and after-shrinkage, whereas relatively low shrinkage is obtained with mineral-filled and impact grades. For example, a typical asbestos-filled material gives a combined mold and after-shrinkage of approximately 7 mils/in. and shows extremely good dimensional stability under environmental changes.

2) *Plasticity of materials:* Shrinkage generally decreases with stiffer flow since more of the chemical change has been effected in the material before molding.

3) *Preheating:* Preheating aids in removing volatiles before molding, thereby reducing shrinkage. This is particularly important when using soft material, for transfer molding, that would normally show high shrinkage. Preheating helps in holding after-shrinkage within a normal range.

4) *Method of molding:* Ample breathing of the mold permits escape of volatiles and may reduce after-shrinkage.

5) *Design of the molded piece:* Adverse effects caused by shrinkage on aging can be minimized by good design of the molded part. Nonuniformity of thickness in a molded piece tends to produce unbalanced shrinkage and consequent warpage. In the design of a piece in which adjacent thin and thick sections are necessary, generous fillets should be used in order that the change in dimension will not be abrupt. Thus, the best design is one in which wall thicknesses are uniform.

Material with high shrinkage on aging should not be used with large metallic inserts or when the part is to be used in an assembly which would prevent the release of strains set up in shrinkage.

Molding variables

A satisfactory molding cycle frequently depends partly upon the behavior of the mold itself; the procedure that will give the best results must be worked out by trial and error. The following observations should be helpful.

Gassiness: This is evident in the form of blisters or streaks of a lighter or darker shade than the main area. It is usually caused by the trapping within the mold, or in the molding, of water or volatiles. Sometimes it may be corrected by increasing the cure time, but usually, measures must be taken to release the volatiles before the part has completely cured. This may be done with a "breathe," which is accomplished by opening the mold ⅛ to ¼ in. while the charge is still plastic, holding it open for a second or two, and then completing the molding cycle.

Similar results may be obtained by partially closing the mold and holding for a few seconds before the final closing. This is called a mold preheat cycle.

Poor densification: This may show as voids within the piece or as a rough or pitted surface. It may be caused by any one or a

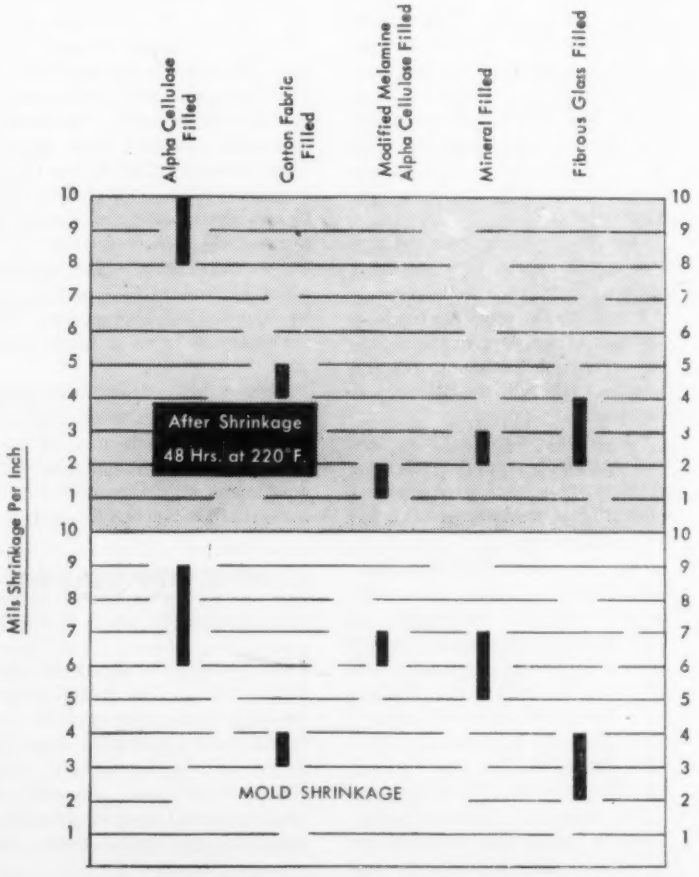


Fig. 3: Mold shrinkage and after-shrinkage of various melamine molding compositions (based on ⅛- by 4-in. compression molded disk)

combination of the following: too stiff a material (i.e., material sets before the flow is complete); too low molding pressure; undercharging the mold; and too fast or too slow mold closing. A study of the molding conditions should pinpoint the trouble.

Dead spots: These are generally white spots in the surface of the piece. They indicate the presence of prematurely cured material. This may result from the presence in the granules of material overcured during preheating, or from too slow a mold close at too high a mold temperature.

Flow and weld lines: Sometimes streaks or definite lines may appear where material has flowed and knitted together. There are several possible causes: 1) use of too stiff a grade of material; 2) excess cure in the transfer pot in transfer molding; 3) because material has flowed around a pin; and 4) because of turbulent flow. Breathe cycles may increase this problem.

Color segregation: This is usually evident as a mottled surface. A slower application of heat during preheating together with a higher final preheat temperature and then a lower temperature in the mold may help. A relatively slow mold-closing cycle is also often helpful.

Tear lines: Sometimes definite breaks will appear in the molded surface. They are usually a result of breathing the mold for too long a period or too late in the molding cycle. Adjustment of the breathe cycle will usually correct the trouble.

Pill break marks: These are surface defects caused by the use of excessively hard preforms resulting from preforming with too high a pressure.

Degree of cure: Parts that have been molded with the cure cycles recommended by the supplier of the molding material and which have satisfactory appearance will generally be well cured. Undercure may show up in the form of poor gloss or blisters. Overcure may cause surface crazing and can affect the strength of the part.

The cure of alpha-cellulose-filled or fabric-filled material can be evaluated by submitting a test piece to a 10-min. boil in sulfuric acid of 0.8% concentration. A properly cured part will show no chalking. Bad undercure will be evident as heavy chalking.

Glass fiber-filled

The foregoing considerations apply equally well to all grades of melamine resins, but additional precautions are required for the glass-filled grades. Because of outstanding electrical and mechanical properties, glass-filled materials are finding increasing industrial acceptance, but they are somewhat more critical to mold. Careful mold cycling is essential to obtain parts with optimum properties.

The glass-and-melamine resin compound has these unusual characteristics: 1) the resin does not impregnate glass fibers; 2) during molding only the resin softens and flows; and 3) the resin can flow away from the glass during molding, giving sections without reinforcement.

To minimize problems caused by this behavior, the following procedures are suggested: a) molding pressures should be 2500 to 3500 p.s.i., as excessive pressure contributes to resin segregation; b) mold temperatures should range between 280° F. for large parts and 320° F. for small parts; c) straight-close cycles should be avoided; d) high-frequency heating should be used whenever possible; e) time of cure should not be appreciably longer than that necessary to give a blister-free part.

Glass-filled materials may have to be hand preformed although the granular grade can be preformed on commercial automatic equipment with adequate care. It is most advantageous to use high-frequency preheating and to preheat as hot as possible. The mold should be "breathed" at least once to eliminate volatiles. These precautions should lead to the production of good molded parts. A good molding will show a uniform grayish color and show no spotting or staining when it is subjected to various types of ink or dye solution.

References

For further information on melamine, see p. 91; on compression and transfer molding equipment, p. 896. Also consult the Subject Index and the Directory Index, p. 1018.

"Salt bowl for cattle," MODERN PLASTICS *34*, 89 (Feb. 1957).

"Now: molded-in decorations for colored thermosets," MODERN PLASTICS *32*, 90 (July 1955).

"Melamine jars," MODERN PLASTICS *32*, 210 (Feb. 1955).

"Case history of a terminal block," MODERN PLASTICS *32*, 125 (Nov. 1954).

"Melamine housing for electric shaver," MODERN PLASTICS *31*, 156 (July 1954).

"Melamine dinnerware," MODERN PLASTICS *31*, 166 (June 1954).

"Factors in electrical insulator design," by W. C. Wickstrand, MODERN PLASTICS *31*, 142 (May 1954).

"Miniature stand-off insulators," MODERN PLASTICS *31*, 210 (April 1954).

"From porcelain to plastics," MODERN PLASTICS *30*, 99 (Nov. 1952).

"Fountain jars of melamine," MODERN PLASTICS *29*, 91 (July 1952).

"Paper plates that take a beating," MODERN PLASTICS *29*, 82 (Feb. 1952).

COMPRESSION MOLDING UREA FORMALDEHYDE

BY R. A. TILEY* and H. J. WEST*

Introduced to industry more than 20 years ago, urea formaldehyde molding compounds were the first thermosetting materials available in an unlimited range of color. Representing new concepts in molding speed, surface hardness, abrasion resistance, grease, oil, solvent, and heat resistance, urea formaldehyde molding compounds opened up broad new fields of application for molded plastics. They are, however, somewhat critical in behavior and must be handled by the molder with due respect to their fast thermosetting characteristics.

Under the influence of heat and

* American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.

essure, molding compounds of ea formaldehyde pass through the characteristic cycle of flow, et, and cure. Chemical condensation is involved during the cure with the liberation of volatile materials, mainly water. To produce the highest-quality moldings, it is necessary for the molding cycle to be so devised as to allow for the effect of these chemical and physical changes.

In comparison with melamines or phenolics, ureas are somewhat more sensitive to heat during the early stages of cure; consequently, the precautions recommended for melamine (qv) apply with even more force to the molding of the ureas. Selection of material with proper flow and cure rate for the design and size of the molded part is of the greatest importance.

Ureas are generally available in plasticities ranging from very soft flow to medium-hard flow. The stiffer materials are used for small parts such as buttons and closures; the freer-flowing materials are suitable for larger articles such as radio cabinets and other housings.

Urea formaldehyde moldings are rated as boil-resistant but not acid-resistant. A suitable test for determining whether or not a part is adequately cured is to boil a test specimen in water for 30 minutes. A well-cured molding shows no chalking nor appreciable loss of gloss.

The following recommendations should be helpful in the handling and molding of urea molding compounds.

Molding conditions

Storage and handling: Ureas are usually supplied either in powder or granular form. It is good practice to store the containers in a dry area, preferably kept below 62° F. Under these conditions the ureas have excellent stability.

Preforming: Urea molding compound in granular form usually preforms well on any commercial automatic equipment. In general, ureas behave the same as alpha-filled melamines. (See "Compression Molding Melamine Formaldehyde," p. 686.)

Preheating: Although more sensitive to heat than the melamines, ureas, as granular material or preforms, can be successfully preheated by either radiant or high-frequency methods, provided certain precautions are taken. Local overheating must be avoided and the maximum temperature for preheated material is 185° F. (See "Compression Molding Melamine Formaldehyde," p. 686, for further suggestions on preheating techniques, which are applicable to the ureas also.)

A prewarming device is sometimes built into the press. One design incorporates an oil-jacketed section in the hopper discharge line. The oil is electrically heated by means of immersion heaters.

Molding temperature and pressures: Ureas are usually molded at temperatures ranging from 275 to 280° F. for large housings, to 350° F. for small parts such as buttons or closures. Molding pressures range from 2000 to 8000 p.s.i.

A "breathe" early in the molding cycle often helps to promote good densification, improve gloss, and shorten the cure cycle. A straight close, however, is often preferred in the molding of small parts. The following tabulation shows cure times for a typical urea molding compound using 4 in.-dia. disks, ⅛ in. and ¼ in. thick, compression molded from cold granular material.

	Cure time	
Temperature	*⅛-in. disk*	*¼-in. disk*
° F.	*sec.*	*sec.*
280	60	135
300	50	120
320	35	90

Buttons and closures can be molded at high temperatures with fast cycles since the flow involved is of minor degree and the small cavity charges quickly reach mold temperature. Large parts involving a high degree of flow in the mold and the transfer of heat through a mass of material are usually required to undergo a longer cycle at lower temperatures.

Shrinkage: Urea moldings show mold- and after-shrinkage ranges comparable to those obtained with alpha-filled melamines. The typical shrinkage ranges are:

Mold shrinkage 0.006–0.009 in./in.

Additional shrinkage, 48 hr. at 220° F. 0.006–0.012 in./in.

Degree of shrinkage depends to some extent on such factors as the plasticity of the material, whether or not the material has been prewarmed, the molding cycle, degree of cure, and the design of the molded piece. Problems caused by after shrinkage can be minimized by good design of the molded part.

Part and mold design

Compression molds can be positive, semi-positive or flash types, the semi-positive type being generally preferred. The most important features in design are those intended to offset stresses set up by differences in shrinkage, flow, and cure. Careful design of the molded part can minimize the effect of such differences. Good and poor practices to be followed are illustrated by Figs. 1 through 10, p. 692 and p. 693.

Openings should be placed so as to minimize flow differences as much as possible. Metal inserts must be thoroughly anchored in the die and should always be placed where there is an abundance of material in the part. Best practice provides a wall of at least three times the diameter of the insert. It is definitely inadvisable for the wall to be less than twice the diameter of the insert.

Wall dimensions should be as uniform as possible, particularly around openings. Differences in wall thickness can cause different degrees of cure and the resulting stresses can give warping or cracking in service.

Obstructions to flow must be avoided as much as possible and sharp-cornered right angles should be avoided since they give rise to eddying, resulting in flow marks and nonuniformity in strength.

Because of after-shrinkage and seasonal changes in dimensions, threads on closures should be made as deep as possible to provide satisfactory thread engagement in case swelling occurs.

Adequate clearance should be

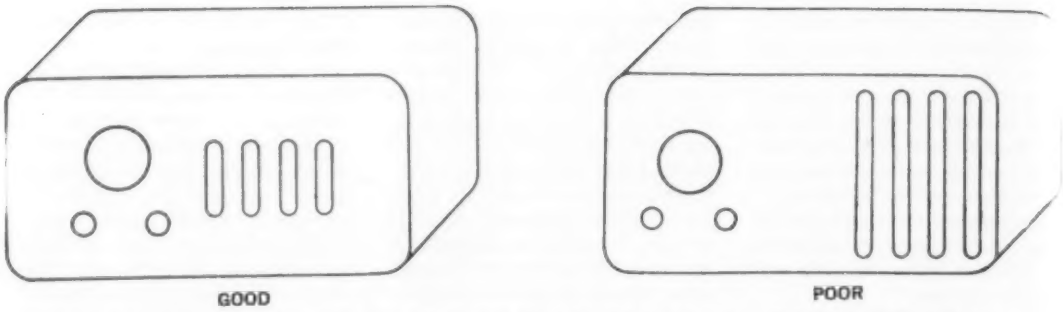


Fig. 1: Good design of molded urea pieces calls for openings to be well spaced and rounded (left), assuring even flow

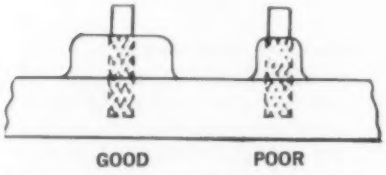


Fig. 2: Ample material should surround inserts: 3 times the diameter of inserts is preferred

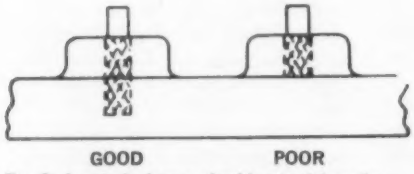


Fig. 3: Inserts in bosses should extend into the molded parts (left) for added strength

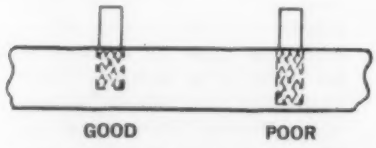


Fig. 4: Inserts extending almost through molded parts (right) often leave weld marks on surface of the part that is below the insert

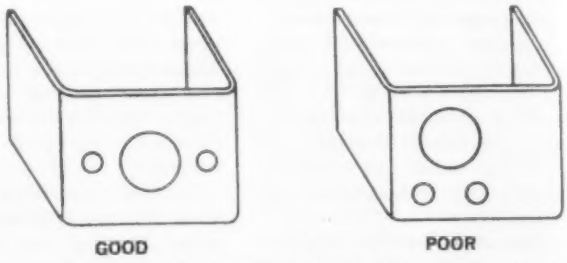


Fig. 5: For deep-draw parts, design at left is recommended for insuring that material flows evenly into vertical sections for formation of walls. Design at right makes for uneven flow

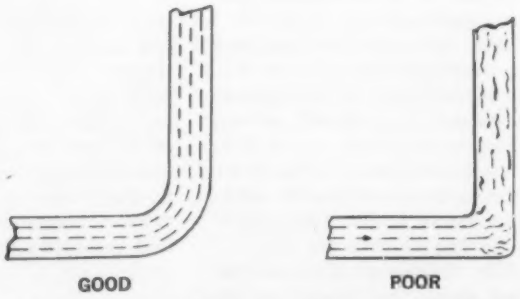


Fig. 6: Corner flow presents no problem if corner is rounded (left); if squared (right), material lodges in corner and impedes even flow during mold closing, causing flow marks and nonuniformity

provided at mounting holes to allow for movement caused by dimensional changes in the molding material.

Typical molded parts

Urea molding applications can be generally broken down into classifications such as: 1) buttons; 2) closures; 3) electric wiring devices; 4) housings; and 5) miscellaneous.

Miscellaneous applications cover a wide range of products, including knobs, dinnerware, and toilet seats, the most important differences being in the size of the part involved. In general, molding of these parts will be the same as for comparable parts in the other categories.

Buttons: Urea molding compounds are ideal for the molding of buttons. Using a stiff, fast-cure material, extremely fast molding cycles are possible. Fast, often semi-automatic flat-bed presses can be used with molds having up to 288 or more cavities.

Small flat preforms are generally used, which can be made from either granular or fine powder material. Cure temperatures are generally relatively high, ranging up to 350° F.

Fine powder material is often preferred for the following reasons: 1) lower initial material cost; 2) the possibility of coloring the material in the shop by ball-milling or micropulverizing with appropriate pigments, a procedure which eases inventory problems for the molder; and 3) greater ease of developing spe-



Fig. 7: Recommended practice when molding urea pieces is to have uniform or nearly uniform wall thicknesses (left). The bead in the center serves as support for the hole. Thin sections around openings (right) should be avoided since they may cure too rapidly and shrink unevenly, thereby resulting in a misshapen piece

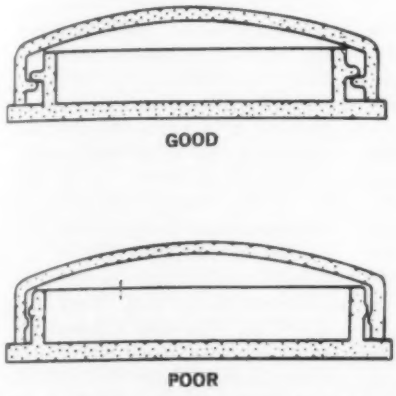


Fig. 8: Deep threads on closures provide satisfactory thread engagement without fear of normal shrinkage or swelling movements

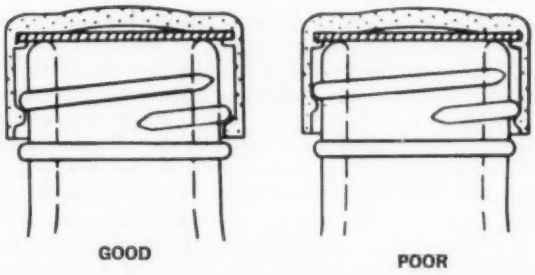


Fig. 9: Another recommended practice when molding urea is to allow clearance for shrinkage and use deeper threads (left) to insure thread engagement if swelling occurs

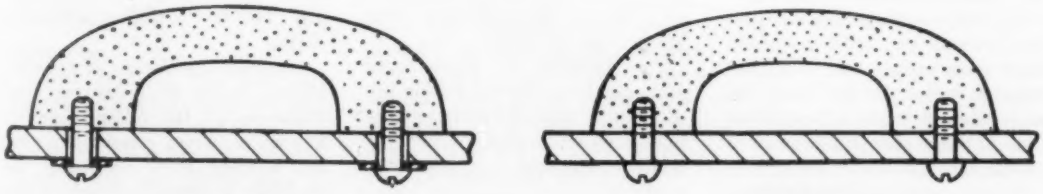


Fig. 10: Clearance at mounting holes allows for shrinkage movements (left); anchoring parts to metal may cause cracking

cial decorative effects, such as swirls, mottles, spatters, or similar attractive patterns.

The finishing of buttons is generally done by first tumbling for flash removal, then cleaning the holes with a special broaching machine sometimes designed by the molder, and, finally, tumbling for polish.

Closures: Because of their unlimited color possibilities, high gloss, and high degree of oil, grease, and solvent resistance, urea moldings are ideal for closures for cosmetic packages and similar articles. A properly-designed part has adequate torque strength for such applications.

Closures are often molded on fast automatic flat-bed presses, using either ball preforms or bulk loading. The force plugs in these presses are sometimes designed to unscrew the closures automatically. As the press opens, the plugs rotate by means of a rack and pinion and serrations in the cavities or out-of-round cavities prevent the caps from turning with the plugs. Rubber fingers complete the unthreading of the pieces. The closures drop into a catch pan and are blown or pushed out of the press; a loading board moves in from the other side to recharge the cavities.

Specially designed rotary presses are also used for closure molding. These are basically rotating tables with self-contained molding units (force, cavity, and ram) located on the periphery. Units can run to 30 or more.

As the table rotates past static

loading and unloading stations, the individual molds (1) open, (2) discharge a molded part, (3) receive a new charge of molding material volumetrically fed into the cavity, and (4) close. The cure is completed as the mold travels round to the first stage.

The part is usually unthreaded at the unloading station by means of a rubber wheel or belt, although in some cases the part is stripped.

This type of press is adaptable to molding small parts other than closures such as wiring devices and tube bases. Its advantages are relatively low tool costs, good molding speed, and ease of changing molds.

Some closure presses are operated manually and the caps are unscrewed individually with an electric or air-driven wrench.

Stiff fast-curing material is generally used for molding closures. Molding temperatures are usually relatively high, ranging from 320 to 350° F. Mold cycles should be kept as short as possible without undercuring the part. Undercure is often evident as blisters. Increasing the cycle a few seconds beyond the blister-point generally eliminates blisters and gives a satisfactory part.

Although a straight close cycle is preferred and most generally used, some presses are valved for breathe cycles. In any case, the press should have a controlled rate of close for uniformity of production.

Electric wiring devices: These include a wide assortment of shapes from switch triggers to multiple wall-plates. They are commonly molded on automatic and semi-automatic flat-bed presses as well as automatic rotaries. Because of irregular shape and design features such as internal bosses and rigs, relatively free-flowing material should be used. Materials classified as general-purpose with medium flow are generally considered to be satisfactory.

Typical molding temperatures fall within the range 300 to 325° F. Preheated material is often an advantage, particularly in molding larger wiring devices.

Housings: Large (200 to 500 tons) flat-bed presses manually operated are generally used for the molding of relatively large parts, such as radio cabinets and other housings. Because of the size of the part and the deep draws usually involved, material with a long flow period should be used. Grades classified as soft, or even very soft, may be required and some manufacturers offer a special grade of housing material.

Dependent upon the size of the housing, it may be necessary to keep the molding temperature as low as 280° F. with a 2½-min. cure for a material with very heavy cross-sections.

The molding of these large parts can be facilitated by the use of molding material preheated by high frequency, rotary can, or other suitable prewarming methods.

COMPRESSION MOLDING TETRAFLUOROETHYLENE

BY FRANK M. CHAPMAN*

Tetrafluoroethylene resins exhibit excellent thermal stability and an unusual retention of physical properties up to temperatures approaching the crystalline melting point. Tetrafluoroethylene resins are unique in that they do not melt and flow as do conventional thermoplastics. When heated above 621° F. (327° C.), the resin undergoes a transition from its normal crystalline state to an amorphous state. In the amorphous state, particles of tetrafluoroethylene resins fuse to give a structure of good strength. Based upon these characteristics, a number of processing techniques have been developed, which consist essentially of a cold-forming operation (preforming), followed by baking (sintering), and then cooling—as in powder metallurgy and molding ceramics.

* Sales Div., Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc.
References were prepared by the editors.

Molding conditions

The tetrafluoroethylene resin general-purpose molding powder (Type I, A.S.T.M. Specification D1457-56T) has a particle size of about 600 microns and a bulk density of about 500 g./liter. Screening before use is good practice in order to insure disintegration of any particles that may be compacted during shipment. This can best be accomplished by employing a series of sieves, ranging in size from U. S. Sieve Number 3 up to a final U. S. Sieve Number 8 or a U. S. Sieve Number 10.

Tetrafluoroethylene resins are not hygroscopic. When shipped, the material contains less than 0.05% moisture. It is advisable to store powders of tetrafluoroethylene in a relatively dry atmosphere and at a temperature of from 70 to 90° F. (21 to 32° C.). This prevents condensation of atmospheric moisture onto the surface of the powder.

Resin which has become wet can be dried in trays filled to a depth of 1 in. and exposed for 1 hr. in a circulating-air oven at a temperature of 300° F. or 149° C.

Preforming: The preform is made by a simple compression of the powder at room temperature. Preforming and tabletting presses used in similar operations with other materials are generally satisfactory for preforming Teflon[1] tetrafluoroethylene resins.

Loading: The weight of powder placed in the mold controls the thickness of the finished piece. Therefore, when close tolerances are needed, it is necessary to maintain a constant weight load. Otherwise volumetric loading devices may be used.

Screening the resin just prior to loading improves the powder flow and reduces the tendency to "bridge" in a narrow die cavity. To produce a part which has a uniform density and shrinkage throughout, the powder must be loaded into the die cavity so as to give even distribution, and then leveled, all before compression. After one charge has been compressed, it is not feasible to load another charge onto this preform, because a fracture line will result between the first and second loadings. This fracture will not weld during the sintering

[1] Trademark, E. I. du Pont de Nemours and Co., Inc.

peration unless the piece is sintered under pressure as in the ase of ram extrusion.

Compression: It is important to avoid entrapment of air in the preform during the compression period. Air entrapment is more likely to occur in preforming large pieces. It can be avoided by reducing the speed of the ram toward the end of the stroke and by providing for a short dwell period when the die is about 90% closed. Too rapid application of pressure may cause cracks perpendicular to compression.

Preforming pressures of 1500 to 10,000 p.s.i. can be used, depending upon the shape, size, and cross-sectional area of the piece. The density of the finished molding increases with pressure up to 4000 p.s.i. but does not increase appreciably beyond that point. The use of excessive pressures may in some cases create fractures in preforms. Such fractures are usually 45° to the direction of compression and are believed to be shear planes caused by forcing one layer of powder past another. When the preform is to be 3 in. or more in length, it is advisable to apply pressure from both the top and bottom of the die to minimize pressure decay and obtain uniform density.

TABLE I: Coining: why and how

Reasons for coining	*Example*	*Temperature of coining mold*	*Coining pressure, p.s.i.*
1. To increase the final density of a molding	large sheets	cold	2000
2. To mold diaphragms or other thin shapes	diaphragm	500-600°F.	1000-2000
3. To produce complex shapes	molding with undercut	cold	5000-20,000
4. To improve tolerances	precision part	cold	2000-5000
5. To form glossy surfaces	sheets	cold	1000-2000
6. To prevent distortion	sheets	cold	500
7. To reduce fractures in large moldings, preform, sinter, and coin in the same mold	cylinders for skiving tape	720°F.	2000

Sintering

The preforms are generally heated in ovens at approximately 720° F. (382° C.) until the phase transition from the crystalline to the amorphous state is complete. The translucent appearance of a free baked molding in the amorphous state is a reliable index that this transition has occurred. Sintering times can be estimated roughly by allowing 1 hr. for each ¼ in. of the thickest portion of the minor dimension. However, when the polymer is sintered in a mold, longer times are required. These times can be estimated from the following relationship:

Sintering time (hr.) = 3.5 (R-R′)

where R is the inner radius of the mold and R′ is the radius of the mandrel.

Large moldings, (3 by 3 by 3 in.) should be heated slowly up to the sintering temperature. The rate at which they are heated through the transition temperature of 621° F. is critical, since the expansion of tetrafluoroethylene resins at this point is greater than at any other temperature. If the preform is heated too rapidly, nonuniform expansion will cause strains, which may produce cracks in the final molded piece.

Electrically-heated, forced-draft, hot-air ovens are generally utilized in the sintering operation. These ovens should have controls capable of maintaining temperature of sintering within from 700 to 730° F. (371 to 388° C.) Temperatures above 730° F. (388° C.) may have a deleterious effect on the physical properties of the molded part. The ovens, as well as the areas for cooling and coining, should be vented to the outdoors to remove any vapors that may have been evolved at these temperatures.

Cooling

Molded parts are cooled from the sintering temperature by free cooling, or coining either in the preform mold or a coining mold (Fig. 1, p. 696). The rate at which a part is cooled from above the crystalline melting point of 621° F. (327° C.) to temperatures of 575° F. (302° C.) influences both the final size and shape of the molding (3).[2] In general, rapid cooling of a molded piece gives less shrinkage, but lower density and greater distortion. Distortion and dimensional tolerances can be more accurately controlled by slow cooling, from the sintering temperature to about 575° F.

[2] Numbers in parentheses link to Special References on p. 698.

TABLE II: Compression ratios

Tetrafluoroethylene resin	*Approximate particle size*	*Approximate compression ratio*	*Typical preform pressure*
Type I[1] ("Teflon" + 1)	600 microns	4:1	4000
Type II[2] ("Teflon" + 5)	250 microns	5:1	3000
No A.S.T.M. Designation ("Teflon" + 7X)	35 microns	7:1	2000

[1] A.S.T.M. Specification D1457-56T
[2] Du Pont's trademark for its tetrafluoroethylene resins

TABLE III: Mold dimensions for rods and tubes

Desired O.D. of piece, in.	*I.D. of mold*
1½ to 5	⅛ in. larger than O.D. of piece
5 to 10	¼ in. larger than O.D. of piece
10 to 15	½ in. larger than O.D. of piece

(302° C.), giving greater, but more uniform, shrinkage to the molding being treated.

Molding without coining

The following procedure is suggested for free cooling or molding without coining.

1) Sieve the resin directly into the die shell (U. S. Sieve Size 8 or 10), and distribute the powder uniformly throughout the mold cavity.

2) Insert the top-end plate and compress to about 4000 p.s.i. (Pressures between 1500 and 10,000 p.s.i. may be used, depending on properties desired and equipment limitations.)

3) Remove the piece from the mold and sinter 1 hr. at 720° F. (382° C.) for each ¼ in. of the greatest thickness.

4) If flat surfaces and close tolerances are important, cool from 720° F. (382° C.) to 575° F. (302° C.) at a rate not greater than 45° F./hr. (0.4° C./min.) and then remove from oven. If slight distortion is acceptable, the part may be removed from the oven without controlled cooling.

Pieces preformed at 4000 p.s.i. and cooled at 45° F./hr. (0.4° C./min.) will shrink about 4% in the dimension perpendicular to compression. A similar piece cooled in air would shrink about 0.7 per cent. Shrinkage at various conditions can be predicted (3).

Coining

Coining is a technique of cooling under pressure in a mold. Two of the cooling methods illustrated in Fig. 1, below, are coining techniques. Pieces are coined for several different reasons as described in Table I, p. 695. However, the techniques are essentially the same. A piece above 621° F. (327° C.), (completely amorphous and translucent in appearance) is cooled under pressure in a mold. It may be removed as soon as it is cool enough to handle.

Pieces after coining will shrink appreciably during the first h[our] but will not reach complete eq[uil]ibrium for at least three da[ys]. It is difficult to predict t[he] shrinkage for any given pie[ce], but an approximate factor of [2.]5 to 2.5%, or 0.015 to 0.025 i[n./] linear in. can be used as a guid[e]. Parts preformed and coined at high pressures will have a lower shrinkage factor than parts processed at low pressures.

Mold design

Good practice in mold design for tetrafluoroethylene resins is similar to that used for thermosetting materials or powdered metals. For ordinary preforming at room temperature, the materials of construction are not critical. However, for accurate work, materials which can be hardened without distortion are recommended. The die shell and mandrel should be harder than the end plates to prevent galling. The molds used to fabricate the common shapes of Teflon tetrafluoroethylene resins are simple.

Preform molds: The cavities of preforming molds must be designed with sufficient volumetric capacity to compensate for the compression ratio and variation in bulk density of the resins. The compression ratios are shown in Table II, p. 695.

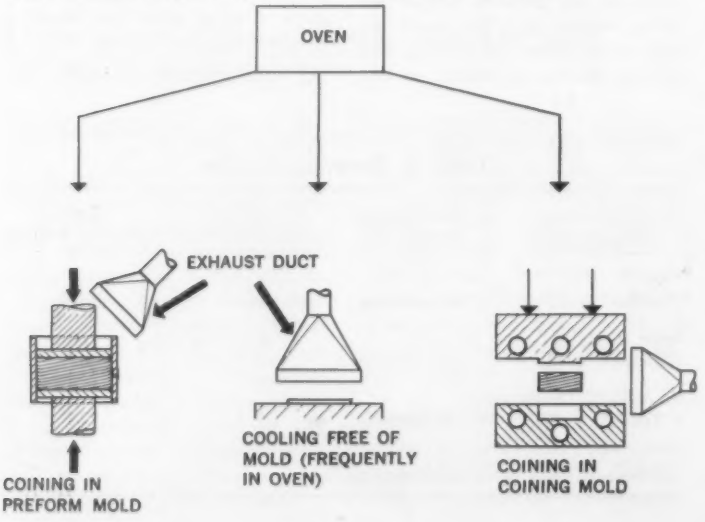
Clearance between the end plates and mold walls is not critical; a diametrical clearance of 0.004 to 0.005 in. is satisfactory. Too large clearances will cause excessive flash.

In preforming it is difficult to force powders of tetrafluoroethylene to flow. For molding complex shapes, this resistance to flow must be considered, and molds should be designed to minimize the requirement for flow, and to permit uniform compression on all sections of the preform. A correct design for a preform mold permits the proper distribution of powder before compression.

The shrinkage of a piece during molding must be considered in designing the preform mold. Having determined the desired process condition, the shrinkage can be predicted. (See discussion on shrinkage in the section on molding without coining.)

Molds for coining: Molds such

Fig. 1: Schematic diagram of procedures in compression molding Teflon



as coining molds which come in contact repeatedly with tetrafluoroethylene resins should be chromium-plated (about 0.003 in. thick) to prevent corrosion. If the molds are to be used for a limited number of pieces, the application of a silicone varnish (such as Dow-Corning Silicone Varnish DC-993) to the surfaces of the mold may prove more economical than chromium-plating.

Shapes that are flexible or tapered can be placed in the coining mold with no difficulty. For pieces with straight sides, a slight taper on the upper part of the coining mold will facilitate the entrance of the piece into the actual cavity. Sometimes the die blocks are cored for cooling or heating. The shrinkage of the part after coining must be considered in designing the coining mold. (This shrinkage is discussed in the section on coining.)

The size of the preform mold required for a coining procedure can be determined by the use of slugs machined from stock which was molded at the selected preform conditions. Following a trial-and-error procedure a slug is machined, which, in the amorphous state, would fit the coining mold. Then the preform die is designed so as to produce this slug.

The preforming die should be smaller than the coining die, since the preform will expand during baking. The linear expansion is about 7 to 9% in the direction perpendicular to the applied pressure, and up to 25% in the direction of pressure. Some shrinkage occurs during the transfer of the part from the oven to the coining mold.

When preforming, sintering, and coining are done in the same mold, the shrinkage depends on the diameter of the piece. Table III, p. 696, can be used as a guide for rods or tubes with wall thickness of ½ to 2½ inches.

In the case of tubes, the core is made to the required nominal I.D.

Effects of fabrication

Properties such as stiffness, flexibility, tensile strength, and dielectric strength are affected by the process variables. Void content and crystallinity are two basic factors that affect the final properties of a molding (2). Since the voids which exist in the preform may be carried over into the finished article, the preform pressure is important. The rate of cooling is a key factor since it determines the final crystallinity of the molding. Table IV, above, indicates the preform pressure, cooling rate, and the level of crystallinity necessary to obtain optimum values.

TABLE IV: Suggested conditions for optimum properties

Property	*Preform pressure*	*Desired crystallinity*	*Cooling rate*
Flexibility	Minor effect	Low	Rapid
Stiffness	Minor effect	High	Slow
Flex life	Maximum	Low	Rapid
Dielectric strength	Maximum	No effect	No effect
Resiliency	Minor effect	Low	Rapid
Impermeability	Maximum	High	Slow
Ultimate strength	Maximum	Low	Rapid
Yield strength	Maximum	High	Slow

When considering a combination of properties necessary for a specific end-use, it is important to note that the physical dimensions of a molded item may determine its final crystallinity by limiting the rate of cooling. Rapid cooling can be achieved for thin sections; however, in thicknesses greater than approximately ⅛ in. the cooling rate is limited by heat conductivity of the polymer.

Molding sheets

A uniform distribution of the resin in the preform mold is essential to the fabrication of sheets. This operation is best accomplished by first screening the polymer directly into the mold through a number 8 mesh screen, and then leveling the powder with a leveling bar. Slight irregularities in distribution can be smoothed out if a rubber pad is placed in the bottom of the mold. When the mold is initially closed, the ram should rest on the powder under its own weight for 3 min./each ¼ in. of the final thickness. The preform pressure of 2000 to 5000 p.s.i. should be applied slowly and maintained for 5 min./¼ in. of final thickness.

Sintering is accomplished in an oven maintained at 700 to 730° F. (371 to 388° C.). The data below can be used as a guide for the estimation of sintering times.

Caliper, in.	*Sintering time at 700–730° F., hrs.*
1/32 to ⅛	1
3/16 to ¼	1½
3/16 to ½	2
9/16 to ¾	3

The preformed sheets are fragile. A practical method for handling them is to sandwich the preform between two thin plates before sintering. This combination is readily handled and can be easily transferred from the sintering oven to a press for coining. Coining at 1000 p.s.i. minimizes warpage and improves the surface of the sheet.

Stress relieving

Residual stresses are present in moldings which have been coined or rapidly cooled. In service, particularly at elevated temperatures, the stresses in these parts will tend to be relieved, resulting in distortion and dimensional changes. These can be kept to a minimum by stress relieving before use. On the other hand molded pieces which have been free-cooled slowly are essentially stress relieved by reheating above the expected service temperature, but below the melting point and slowly cooled. As a rule, heat treating for 1 hr./in. of thickness is adequate when the molding is cooled slowly.

When extreme deformation during coining results in a high stress level, a molding will tend to revert to the original shape and dimensions of the preform at elevated temperatures. In such

cases, service will be limited by the temperature at which the part distorts.

Toxicology

Adequate ventilation is a recommended precaution against inhalation of small amounts of gaseous decomposition products encountered when processing tetrafluoroethylene resins at temperatures above 400° F. (204° C.). The use of proper ventilation is so effective that there are no known cases of ill effects where suitable precaution is taken.

Special references

1). Du Pont's Information Bulletin, *Molding Techniques of "Teflon" Tetrafluoroethylene Resin.*

2). "Effects of fabrication on the properties of 'Teflon' resins," SPE J. (June 1956).

3). "Influence of process variables on shrinkage of moldings of 'Teflon' polytetrafluoroethylene resins," SPE J. (Feb. 1957).

References

For further information on tetrafluoroethylene, see p. 119, on compression molding equipment, p. 896. For data on extrusion, see p. 704; also consult the Subject Index and the Directory Index for additional information on the manufacture and processing of tetrafluoroethylene.

"Forming problems overcome," MODERN PLASTICS *30*, 121 (Feb. 1953).

"Fluorocarbons face fame and fortune," MODERN PLASTICS *30*, 79 (Dec. 1952).

"Fluorocarbon moldings," MODERN PLASTICS *27*, 148 (July 1950).

"Teflon components and coatings," Product Engineering *23*, 143 (Sept. 1952).

COMPRESSION MOLDING PHENOLICS

BY A. J. GUZZETTI*

Commercial phenolic molding ing materials are available in a great variety, and the use of a specific type usually depends on the properties desired in the end product. These compounds incorporate either organic or inorganic fillers in ground or in macerated form. Some of the more commonly used fillers are wood flour, cotton flock, asbestos, mica, natural fibers, and even paper. More recently, fibrous glass, chopped glass cloth, and the new synthetic fibers have been introduced. The incorporated fillers sometimes cause a bulky molding compound. In such cases, the molding material is further processed to yield a product in pellet form, which results in easier handling during the molding process.

The terms "general-purpose," "impact-resistant," "heat-resistant," "chemical-resistant," or "special-purpose," are commonly employed to describe the various types of molding materials. This descriptive nomenclature usually refers to the outstanding properties that will be found in an end product fabricated from the specific material. Finished molded pieces are hard, rigid, and durable. With the diversity of phenolic molding material composition, the range of end products is almost unlimited, ranging from switch plates to large molded drawers.

To satisfy the thousands of phenolic molding applications, each with its own design, requires versatile and flexible fabricating techniques. It is also necessary to know how to handle the molding materials efficiently and economically, to have an understanding of good product design, and a thorough knowledge of the material and technique variables involved.

Preheating

Because of the many advantages that it offers, preheating of materials prior to molding is widely used. For example, it shortens the necessary cure time, and it reduces the magnitude of pressure required for the molding operation. Furthermore, any drying that is realized by preheating usually improves the electrical properties of the molding material and reduces shrinkage. Of the three general types of preheating —electronic, steam, or dry air— the electronic, or high-frequency, method is most frequently used.

Electronic preheating offers the advantage of very fast uniform heating throughout the mass of material. This directly implements savings in cure time, which tend to offset the initial cost of electronic preheating equipment. The economic advantages of electronic preheating and automatic molding have been combined, during the last couple of years, into a single automatic process. In such an operation, the powder or preformed material is electronically preheated, automatically transferred to the compression or plunger molding press, and automatically molded and ejected.

Where improved electrical properties are important, dry air preheating is of definite value because it effects greater drying of the material. However, it is the slowest preheating method and does little in the way of plasticating the material.

Steam or moist-air preheating makes possible control of moisture content in the material. On the other hand, it is much slower than high-frequency preheating and, generally, is in very limited use at the present time.

Molding methods

Molding methods generally fall into two broad classifications. In compression molding, the material, either loose or preformed, is charged into a heated mold. The mold is closed, generally under low pressure, until the two halves of the mold exert pressure on the material. Under this heat and pressure, the material becomes soft. As the mold continues to close, the softened material is forced into all parts of the cavity. Just before the mold is completely closed, high pressure is exerted and causes final and complete filling out of the mold. The high molding pressure is continued for the necessary period of time required for curing. Then, the mold is opened, and the molded part is removed.

The second type, plunger or transfer molding, involves the application of heat and pressure to the material outside the mold.

* Bakelite Co., Div. Union Carbide Corp., 30 E. 42 St., New York, N. Y.

References were prepared by the editors.

This secondary chamber is connected to the mold cavity by an opening called a sprue and channels from the sprue to the cavities, generally called runners. Again, pressure is continued for the time necessary for cure, after which the mold is opened and the parts removed. In this operation, a cull is sometimes left in the external chamber, and this must be removed before the next cycle is started.

Compression molding

Compression molding is best suited to producing parts of large area or deep draw. Furniture drawers, radios, and housings for instruments, meters, office and business machines, and similar box-like structures are usually compression molded. Compression molding is also commonly employed for large-scale production of simply designed pieces such as closures, tube bases, and buttons.

Compression molding is not normally recommended in the molding of intricately designed articles containing undercuts, side draws, small holes, and inserts. The flow of the material under high pressure may distort or break pins and dislodge inserts. Such parts should usually be made by transfer (or plunger) molding. However, the use of electronically preheated powder in compression molding appears to be overcoming most of these disadvantages and may broaden the application of compression molding.

Molding methods may also be classified according to the use of hand molds, and semi-automatic and fully automatic equipment.

When hand molds are used, the mold is assembled and charged on the bench, transferred to a press, and then disassembled and discharged on the bench. This method is used only with intricate molds and for extremely short runs. In semi-automatic molding, the mold is mounted in the press, with or without knockout pins, and is charged and discharged manually. Presses of this type may be manually controlled or of semi-automatic operation. The greatest volume of molding, particularly of large pieces, is performed on equipment of this nature. Several automatic machines may be run by one operator who provides a supply of material for each machine and periodically removes accumulated pieces which have been automatically molded and discharged. This method, employed for extremely long runs of small pieces such as closures and tube bases, is gaining increased recognition because of the labor savings permitted.

In automatic compression molding, the majority of presses feed essentially unpreheated powders or preforms to the mold. Thus, these machines (that do not provide preheating) have a particular sphere in which they are economically advantageous. For example, these machines are not recommended for the molding of pieces that: 1) contain inserts (unless these are fastened into the cooled piece as are tube base pins), since an operator is required to put the inserts in either the mold or hot piece; 2) require the use of shrink fixtures to prevent warpage on cooling; 3) have delicate core pins or extremely intricate detail; and 4) have thick sections which almost require H.F. preheating to achieve reasonable cure times. Pieces which are free from all these conditions can usually be molded economically on automatic presses from unpreheated powder.

In some cases, however, pieces subject to condition 4 (and sometimes also condition 3) can be economically molded on automatic compression equipment used in conjunction with automatic H.F. preheat provided: 1) spherical preforms can be used; or 2) powder can be preheated sufficiently and still be handled successfully.

The advantages to be realized in the use of compression molding are important from several standpoints. First of all, there is a wide variety of available semi-automatic and automatic compression molding machines. From a materials saving standpoint, there is less waste because there are no culls or runners to contend with. There is not much tendency for pieces to distort because of generally lesser filler orientation and more uniform flow pattern. Finally, it has been found that the use of compression molding provides better retention of mechanical properties, particularly with impact materials having coarse fibrous fillers.

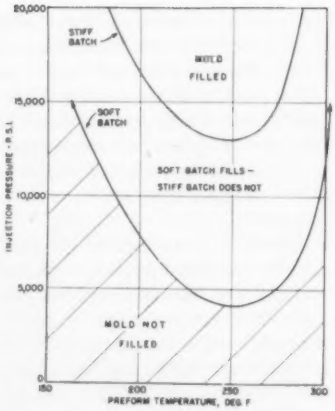


Fig. 1: Effects of pressure, preform temperature, and plasticity on fill-out in plunger mold. (Mold temp., 335° F.)

Plunger molding

Plunger molding has several advantages to offer over compression molding. The filling of intricate molds or molds with long core pins or inserts is accomplished better by plunger molding. In addition, shorter molding cycles are possible with plunger molding. There are two reasons for this:

1) The loading time is usually shorter since fewer and larger preforms are used. These can be preheated more rapidly and effectively in dielectric and steam preheating equipment. (Some dielectric preheaters are in use with loading boards for multiple-cavity compression molds, but they are more expensive.)

2) Shorter curing times are possible, particularly in thick sections. This is true because the material is heated as it is forced through the gate and the volatiles escape through vents and clearance spaces around movable pins.

Easier finishing is also possible with plunger molded articles since flash is quite thin or nonexistent. Gates can usually be made sufficiently thin and so located that their removal is easy and inexpensive.

There are several disadvan-

tages of plunger molding when compared with compression molding. The material left in the pot and runners is completely reacted and must be discarded. This loss is unavoidable and can represent a sizable percentage of weight of the pieces which are thus being molded.

Loss of mechanical strength with improved-impact materials containing fibrous fillers has been observed in plunger molding. Furthermore, plunger molding is less adaptable to the fabrication of large pieces, and the development of automatic plunger molding machines has been slower than that of automatic compression molding.

Plunger molds

Experience with different types of presses and mold designs indicates the following to be good practice: Individual hardened steel cavities should be mounted in the chase plate, which should be cored for steam heating. Runners and gates should also be hardened. The cavity and chase plate land areas should be ground and polished to insure maximum surface contact when the mold is closed. This prevents flashing of the material from cavities and runners.

The mold should be adequately supported directly under the pressure chamber to prevent distortion or sagging. If this precaution is not taken, mold distortion will result and cause flashing and nonuniform filling of the cavities.

The gate to the cavity should be located on an easily accessible surface, so its removal may be accomplished by a simple finishing operation. Care should be taken not to gate the cavity directly opposite a mold pin or other protrusion in the mold. Gating at such a point will cause the stream of material entering the cavity to change its direction of flow and divide into two or more streams, tending to cause weld marks and knit lines and to decrease the physical strength of the molded piece. Gate size may range from pinpoint to 0.500 in. wide and 0.125 in. deep. In the molding of comparatively small pieces using general-purpose phenolic material, a gate 0.100 in. wide and 0.015 in. deep will usually prove satisfactory.

Proper venting of the mold is essential to permit the escape of air trapped in the mold prior to injection of the material. Vents should be located on the same half of the mold as the runners, at the point which fills out last. This is generally furthest from the gate, thus facilitating the sweeping out of air and preventing gas entrapment. Vents 0.002 in. deep and 1/16 to 1/8 in. wide generally are adequate.

Molds used in plunger molding normally are multiple cavities. However, the number of cavities possible in a plunger mold is less than that possible with a compression mold. As a rule, plunger molding is performed on semiautomatic equipment. Fully automatic machines are being used, particularly in the molding of small pieces, and the development of this process on an automatic basis is continuing.

Mold design

In designing a piece to be molded, adequate draft must be provided to permit easy removal of the piece from the mold. Wherever possible, corners should be rounded to avoid stress concentrations. Sections should be of uniform dimensions; nonuniform sections promote gas entrapment, warpage, and internal stresses. Where inserts are necessary, special provisions must be made for them. In calculating mold dimensions, care must be taken to make proper allowance for shrinkage and cut-off. Small undercuts may be used in one of the mold halves to insure retention of the piece on a particular half of the mold. Proper design of the mold is also important from the general standpoint of molding materials. Specifically, a sufficient number of steam channels or electric heating elements (depending on the method used) must be carefully located throughout the mold to insure uniformity of temperature from point to point.

Materials and methods used in the construction of molds are of primary importance in determining both the quality and cost of the finished piece. Molds machined from tool steel, although expensive, are superior to other types. To produce molds of this type, tool steel is machined to the proper shape, hardened, and then ground to final dimensions. Hobbing steel may be used to produce molds where a large number of cavities are to be made. In this process, the individual cavities are formed by pressing a hardened steel hob of the desired shape into low-carbon, or hobbing steel, which is then case-hardened to produce the finished mold cavity. Chrome-plating of metal molds provides an excellent surface, improves release properties, and increases resistance to mold staining.

Molding operation

The molding of phenolic materials may be performed under varying conditions of temperature, pressure, and cure time. The temperature of the charge may vary from room temperature, when preheating is not used, to 300° F., the maximum preheating temperature normally employed. Mold temperatures vary from 290 to 400° F. but are generally in the range of 315 to 365° F. In compression molding, the average pressure is approximately 3000 p.s.i. A pressure of this magnitude is usually sufficient to mold the majority of parts, using general-purpose molding materials. Pressures used in plunger molding processes average about 8000 p.s.i. Molding cycle time may vary from a few seconds to several minutes and is greatly affected by the nature of the piece, material, and technique. All of these molding conditions are affected to a greater or lesser degree by the design of a specific mold and by the types of material to be used. Thus, in selecting conditions for a particular molding operation, the size, techniques, and intricacies of the molded piece must be considered along with such interacting variables as type of material and its plasticity.

The two major considerations in fabricating a piece by compression or plunger molding are the production of the piece in keeping with specifications and the most economical production of this specified piece. To attain these ob-

jectives, a thorough understanding of the abovementioned molding, piece design, and material variables is necessary. And once optimum conditions have been agreed upon for a specific molding operation, it is imperative that these conditions be carefully maintained and controlled throughout the entire job. Pieces thus produced will exhibit uniformity of specified properties and will have been economically produced under the closely controlled optimum conditions.

Material plasticity

The plastic behavior of a molding material as it is molded is determined by two things: 1) the flow properties of the material; and 2) the molding conditions. The rheological (flow) properties of the material are numerous and complex, and their complete definition would require determination not only of several rheological properties as a function of temperature, but also the time rate of change of these properties. For practical purposes, material plasticity is defined in terms of specific molding tests which roughly simulate conditions of use in the field. These ratings do not, and cannot, completely define material plasticity. They do serve: 1) to predict relative performance of different batches of the same material under all conditions of use; and 2) as a first approximation of relative performance under various molding conditions.

It is evident that a low degree of plasticity or a high degree of plasticity or a high degree of reactivity may result in failure to fill the mold properly. In this case, the rate of flow and reactivity of a material—under the particular conditions of temperature, pressure, and time cycle of operations employed—are such that the material becomes too stiff to flow further. Excessively soft material may also give rise to a variety of less evident molding difficulties such as: 1) gas entrapment; 2) poor release; 3) slower cure; 4) loss of any mottle pattern; 5) flashing of transfer molds; and 6) greater shrinkage. Appearance may be adversely affected by either excessively high or low plasticity.

Molding plasticity of a single batch of material can be altered by such conditions as preheat temperature and molding cycle. The principal molding conditions which affect material plasticity

TABLE I: Variables affecting mold shrinkage

Molding variables		*Mechanism*			
		Thermal contraction		*Elastic recovery*	*Plastic deformation*
Principal variable	*Effect on shrinkage of increasing variable*	*Piece temp.*	*Coeff. th. ex.*	*Pressure on piece*	*Mechanical distortion*
Mold temp. (T_m)	Increase	X			
Preheat temp. (T_p)	Decrease		X		
Cure time	Decrease		X		
Pressure	Decrease			X	
Ejection time	Increase				X
Cooling rate	Increase		(Mechanism not known)		
Mold and piece design variables					
Flow pattern	Increase-decrease		X		
Gate size	Decrease			X	
Cut-off (more pos.)	Decrease			X	
Depth of draw	Increase-decrease			X	
Thickness	Increase		X		
Material variables					
Plasticity	Increase		X	X	
Moisture	Increase		X		
Filler type	Increase-decrease		X		

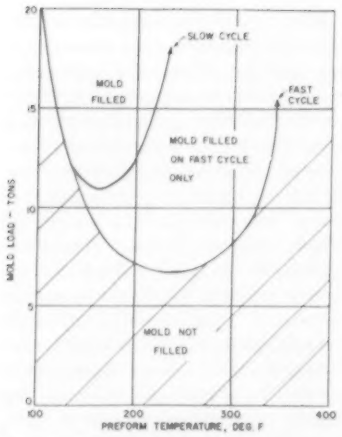


Fig. 2: Effect of time cycle of operations on range of mold fill-out of compression mold. (Mold temp., 335° F., H.F. preheat)

are: 1) pressure on the material; 2) preheat temperature; 3) time cycle; 4) mold design, and 5) mold temperature. The combined effects of some of these variables are illustrated by Figs. 1, p. 699, and 2, above.

Figure 1 shows the ranges of preform temperature and injection pressure over which a particular plunger mold could be filled with material of two different plasticity grades. It is seen that as preform temperature increases, the pressure required to fill decreases to a minimum and increases again. At the minimum, the softening effect of increasing preheat is offset by the increasing rate of the chemical reactions which result in hardening. Though the two batches differ widely in plasticity (as evidenced by the difference in the minimum values of the two curves), the pressure required to fill the mold with the softer batch varies over an even greater range as the preform temperature changes. This is shown by the fact that, at 175° F. preform temperature, the softer batch requires more pressure (15,000 p.s.i.) to fill the mold than did the stiff batch at 250° F. preform temperature (13,000 p.s.i.).

The effect of the length of the molding cycle on plasticity, as judged by mold fill-out, is illustrated in Fig. 2. These data were obtained in a compression mold using a single sample of material. The fast cycle involved transferring the preheated preform to the mold, running it for 10 sec., and then closing the mold rapidly under pressure. In the slow cycle, transfer and run-up time were increased to 30 sec. and the closing under pressure was slowed by restricting the pump output.

It is evident that the slower cycle greatly increases pressure requirements and decreases the allowable range of preform temperatures. This is due to the greater amount of reaction occurring in the preheated material during the longer time required for transfer and flow in the slower cycle. The data show that very close control of time is required if the advantage of high-temperature preheat is to be fully utilized.

Variations in mold design, such as gate size (in transfer molds), wall thickness, and depth of draw, can exert similar profound influences on pressure and preheat requirements. Gate wear can alter pressure demands appreciably. Preform temperature is rarely controlled to a specific value in molding operations. Variations in preform density (resulting from changes in preforming pressure) and electrode spacing may result in significant differences in temperature and, consequently, in plasticity.

Most molding compounds are offered in a rather wide range of plasticities to meet nearly any set of conditions encountered in various molding operations.

Molded piece dimensions

Molded plastics parts, with few exceptions, are smaller than the molds from which they are produced. This difference in dimensions, or molding shrinkage, though it may be only a few tenths of 1%, is of considerable importance when dimensional tolerances are exacting. Components of assemblies, large pieces which are to be spray painted through a mask, and long molded furniture drawers are examples of moldings requiring very close control of certain dimensions, sometimes as close as 0.001 in./in. of length.

Molding shrinkage is defined as the difference per unit length, in any linear dimension, of a mold and a molded piece when both are at room temperature. The shrinkage is equal to the dimensions of the mold minus the dimension of the piece divided by the dimension of the mold. A differentiation should be made here between molding shrinkage and so-called "after shrinkage." The latter usually results from exposure of the molded piece to certain environmental conditions.

The mechanisms by which molding shrinkage occurs are: 1) thermal contraction, which is a function of the ejection temperature of the molded piece and coefficient of thermal expansion; 2) elastic recovery (expansion that tends to reduce shrinkage): this depends directly on the compressibility of the material and the actual pressure exerted on it; and 3) plastic deformation, which is caused by mechanical distortion.

The variables affecting these shrinkage mechanisms can be divided into three categories: 1) molding; 2) mold and piece design; and 3) material. Table 1[1], p. 701, summarizes these three types of variables.

Molding speed

In recent years, the rapid growth of thermoplastics has brought these materials into competition with phenolics in many fields where economy of molding is the principal consideration. Since the higher molding costs of phenolic materials are largely a result of longer molding cycles, interest has been concentrated on reducing phenolic molding cycles to a point nearer those of the thermoplastics.

The minimum requirements for commercially cured phenolic pieces are usually: 1) sufficiently rigid: [so as not to A) strip prematurely over undercuts designed to hold it in one or the other mold half, or B) distort unduly during ejection and subsequent handling before it is cold]; and 2) free from undercure blisters caused by entrapped air, water vapor, or volatile matter formed during cure.

As with plasticity and shrinkage, molding speed can be varied

[1] "Shrinkage of thermosets," by A. J. Guzzetti, MODERN PLASTICS *34*, 111 Feb., 1957.

greatly by altering molding conditions. The most important variables affecting molding speed are charge temperature and mold temperature. The charge temperature, or temperature of material entering the mold, is the biggest single variable for pieces of any size. It is especially important in the case of thicker pieces because the poor thermal conductivity of phenolic materials retards heat transfer from the mold to the center of the material. Conversely, mold temperature is most important in thin sections where low charge temperatures are used.

Time, temperature, and pressure are the variables which control the cure of a thermosetting material. The effect of time is always in the same direction. Longer cure time, unless decomposition or rearrangement occurs, results in greater rigidity up to the point at which essentially complete reaction is attained.

Variations in temperature affect rigidity by two mechanisms which are opposite in their effect:

1) Higher temperature results in faster reaction and, thus, in a more highly cross-linked, rigid, molecular structure at any fixed cure time.

2) For any given molecular structure, higher temperature results in lesser rigidity by virtue of reduction in the retardation times.

Mechanism (1) predominates at low degrees of cure (short cure times and lower temperatures), and mechanism (2) stands out at higher degrees of cure. These effects are shown in Fig. 3, right. At the shortest cure time, pieces cured at 365° F. were almost three times as rigid as those cured at 305° F. due to faster chemical reaction at the higher temperature. As cure time was lengthened, the effect of temperature on retardation time became more of a factor. At the longest cure time, pieces cured at 365° F. were only about half as rigid as those cured at 305° F. Thus, if cure time is not also taken into consideration, the resultant cross-over can give rise to conflicting reports on the effect of temperature.

An increase in molding pressures, at constant temperature, generally appears to retard the curing reaction with a subsequent reduction in rigidity. Experimentation has indicated this to be true for one-step and two-step materials, for woodflour-filled and mineral-filled materials. A rise from 1000 to 6000 p.s.i. of pressure has been found to cause reductions in apparent modulus that vary from within experimental error to 20 to 30 percent. This does not mean that reducing molding pressure will always result in greater rigidity or faster cure. There are other controlling factors, including the heat generated by mechanical work done in flowing the material, which are likely to predominate. But it does suggest that, with flat pieces where very little flow is involved (for example, switch plates), cure may sometimes be accelerated by use of lower pressure.

The minimum blister-free time decreases sharply as preform temperature is increased. In the case of pieces having a very thick section, the reduction effected is as much as 75 percent.

The maximum preform temperature at which pieces may be molded is limited by material properties and by the formation of appearance defects (e.g., shallow surface blisters, etc.), but the chief limitation on the maximum preform temperature is the time cycle of operations. This is illustrated by Fig. 2, p. 702, where it is shown that increasing the time required to transfer the preforms to the mold and slowing down the press resulted in a drastic reduction in the maximum temperature to which the material could be preheated and the mold still filled.

Automatic molding

More and more development work is being conducted in the field of automatic molding processes which combine fast high-temperature preheating, rapid material transfer, and faster-closing presses.

Automatic preheating of preforms, coupled with automatic compression molding, although patented years ago, has only recently been commercially exploited. This process, however, permits productivity increases of

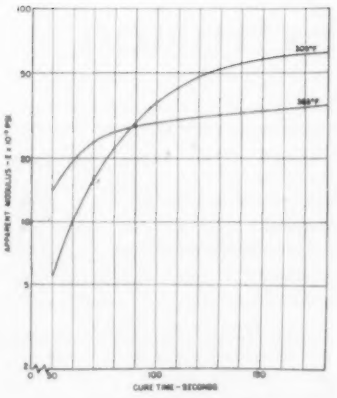


Fig. 3: Effect of cure time on rigidity of a general-purpose phenolic at two temperatures

50 to 100 percent over that obtained with cold powder. Considerable success has also been achieved in automatic powder preheating.

In all automatic processes, means must be provided to afford close control of molding conditions. This is necessary to obtain the full advantages of higher material and mold temperatures without danger of thermal deterioration. Close control of molding conditions will also permit material manufacturers to formulate compounds having faster molding speeds but greater susceptibility to thermal abuse.

References

"Advances in thermoset molding," by E. F. Borro, MODERN PLASTICS *33*, 145 (May 1956).

"Automatic molding of coil forms," MODERN PLASTICS *33*, 138 (Mar. 1956).

"Fully automatic compression molding *vs.* transfer molding," by A. A. Hutchins, MODERN PLASTICS *27*, 131 (Apr. 1950).

"Compression and transfer molding of guided missile parts," by L. B. Keller and W. R. McGlone, SPE J. *12*, 32 (Apr. 1956).

"Fully automatic molding," by Quenton M. White, Plastics Tech. *1*, 545 (1955).

"Phenolics for large moldings," by F. J. Donohue, SPE J. *7*, 26 (Feb. 1951).

"Conditioning phenolic materials for stability in molding," by J L. Formo, SPE J. *7*, 13 (Feb. 1951).

Extrusion

IN THIS SECTION

Extrusion Introduction 704
Acrylics 709
Trifluorochloroethylene 712
Cellulosics 715
Nylon 66 717
Polycaprolactam Nylon 721
Tetrafluoroethylene 725
Polyvinyl Chloride 728
A-B-S Polymer Blend 731
Polyethylene 732

Extrusion is any process by which a material that does not deform rapidly under light loads is forced under relatively high pressures to flow through a restricted opening. The operation imparts a new shape to the extruded material or, as it is also known, the "extrudate." Toothpaste forced out from its tube, hamburger from a meat "grinder," or cake decorations from a syringe are everyday examples of extrusion. (In all three instances, there is a shaping function as well as a transport function.)

In plastics processing only screw extrusion and ram extrusion are used, and ram extrusion has important application only to the processing of TFE resin (Teflon). The discussion of ram extrusion, therefore, will be found in the article on extrusion of TFE resin, p. 725. This introduction will be concerned only with screw extrusion.

Extrusion process

A screw extruder (see Fig. 1, p. 705) has five basic parts: the screw, the barrel that contains it and provides drag on the material, a drive to turn the screw, a feed port, and the die, or shaping orifice, at the delivery end. Since most plastics are too rigid to extrude at room temperature, they must be heated considerably before they pass through the die. Since at least part of this heat is supplied by direct transfer through the barrel, heating equipment is furnished with the extruder.

The screw can be thought of as having three zones—feeding, plasticating, and metering zones—though the transition from one to another may sometimes be indistinct. Each has its function, as discussed below.

Feeding

The plastic to be extruded enters the feed hopper in the form of small pellets (about ⅛ in. on a side) known as molding powder. Very soft stocks, such as plasticized vinyl, and various rubbers may be fed in strip form. The powder falls into the screw and attempts to rotate with it, but is held back by the drag of the stationary barrel. Because it is dragged back (the term "drag flow" applies to this action and is discussed on p. 705), the spiraling screw flight advances it axially. If the drag of the barrel could make itself felt fully throughout the entire mass, the plastic would advance in the form of a plug, much as a nut that is held advances when the bolt is turned. On the other hand, if there were no friction at the barrel surface, we have the opposite action: no matter how much the screw turns, there is no advance (analogous to a nut that is *not* held).

The feeding action in plastics extruders occasionally approaches one of these extremes, but more nearly always lies somewhere between. The rate of advance thus depends on the friction between barrel and plastic and between the screw and the plastic, as well as on the screw geometry. Back pressure also affects advance, as would be expected. Equations describing solids movement in extruders were developed by Darnell and Mol (11)[1], who assumed that the solid mass is not sheared, i.e., behaves as a plug. Calculated results agree well with experimental outputs measured in 2-in.-dia. screws; divergences are due mostly to the difficulties of determining the coefficients of friction to be used.

Some of the qualitative results of this theory were reached earlier by H. Decker (35), whose equations, however, were quantitatively inadequate. They are: 1) minimize friction between the plastic and the screw, by minimizing the contact area on the screw, by polish, or by chrome plating; 2) develop as high a coefficient of friction as possible between the plastic and the barrel, by roughening the barrel surface or even cutting grooves in it; 3) choose the lead and profile of the screw to get the greatest axial components of motion and pressure; and 4) have a high bulk density in the feed. These conclusions, borne out by the later quantitative work (11), imply that multiple flights are detrimental to good feeding, and that dense, compact pellets rather than fluffy feeds should be used.

The form of the particles fed into the extruder is also important, particularly in the smaller machines where the particle size is almost as large as the thread depth. Kennaway (20) tested various polyethylene feeds—rough cut particles, cubes, cold-cut spaghetti (cylinders), and hot-cut spaghetti (spheroids)—and found that spheroids gave higher, more regular output.

Plasticating

In the next stage of the extruder, the pellets are crushed together and eventually fused into a molten mass that wets the barrel and screw surfaces. During this transition, the density of the material, in bulk, increases sharply, sometimes as much as six-fold. With molding powders a two- to four-fold change is common. This change is allowed for by a corresponding change in the volume of the screw flight, and the ratio of the screw volume at

[1] Numbers in parentheses link to References listed on p. 708.

the feed section to that in the last turn before the die is called the *compression ratio* of the screw.

Since we still know very little about the details of what happens to the feed particles during this plasticating or compression stage, there is still tremendous divergence among screw designers and extruders as to how this zone should be designed. There are screws in which the change in volume occurs almost as suddenly as a stair step—in half a turn of the screw. In others it begins with the second turn and is completed in the next to last, by gradually decreasing the lead or the thread depth of the screw, or both. In some, thread depth is decreased conically, in others helically. Information is lacking that would permit a sound decision as to just what method to use. What is known about the subject, however, is as follows: 1) compression should not begin until the feed has been brought up to a temperature in the neighborhood of its heat-distortion temperature or else bridging and stoppage of flow may occur; 2) if the feed section preceding compression is too short, slight fluctuations in back pressure can cause wide variations in feed rate; 3) a comparative study of polyethylene extrusion in two screws having the same compression ratio showed the decreasing-thread-depth screw gave higher, steadier rates than the decreasing-lead screw (27). Also, for other reasons, given below, the decreasing-thread-depth method is much preferred to the decreasing-lead method.

The metering zone

Most screws made today for extruding plastics have a definite metering zone. This is the last threaded section of the screw, relatively shallow in thread depth, and with constant lead and depth throughout. As its name implies, its function is to regulate the rate of extrusion through the die. If the extrudate dimensions are to be kept within narrow limits, variations in extrusion rate must be reduced to the attainable minimum. Since the extrudate is usually handled by take-off equipment running at constant lineal speed, any variation in extrusion rate causes an equal variation in the cross-section of the product.

The operation of melt screws, and metering screws especially, is well understood. It happens that in melt screws, the non-Newtonian flow behavior of plastics has little influence on screw performance, so Newtonian flow theory applies rather well. The problem of output and pressure development in screw pumps was first solved by Rowell and Finlayson (36) and subsequently tackled with varying degrees of success by several other parties, apparently working pretty much in ignorance of the work of Rowell and Finlayson and each other. From the standpoint of plastics extrusion, the most thorough treatment appeared in 1953 (25). This symposium contained seven papers, five dealing with the theory, experimental behavior, and design of melt screws, one with scale-up of plasticating extruders, and one with heat transfer in extruders. Equations were developed giving the output, die pressure, and power consumption of melt screws in terms of their dimensions, speed, and the melt viscosity. While most of the work was directed toward metering screws, screws of varying dimensions were also considered. At the January 1953 conference of the SPE, three papers (28, 29, 30) that make up a good introduction to the subject were presented.

Melt flow theory

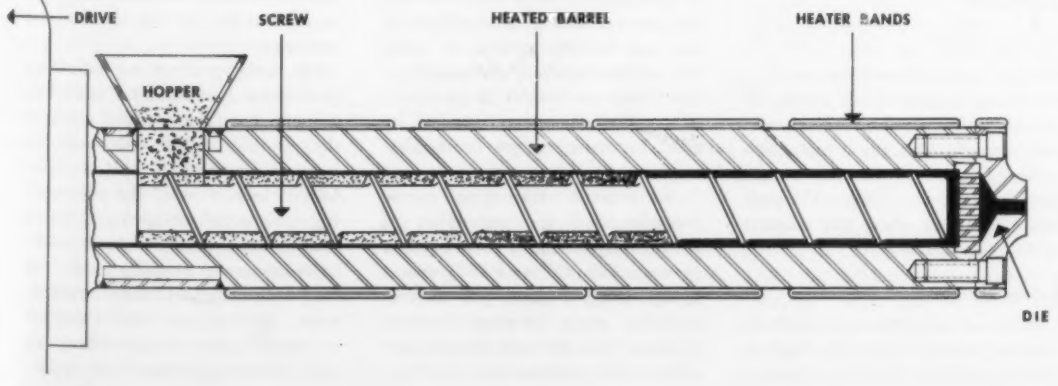
The notion of drag flow is fundamental. Here, however, the material being dragged is a viscous liquid that shears uniformly throughout its depth. The drag flow forces the melt toward he discharge end of the screw. However, the die offers resistance to discharge, so pressure is built up there. This pressure tends to force some of the liquid backward toward the feed end. At the same time, there is an increase of pressure from one turn to the next which causes backward leakage through the clearance between the barrel and the flight land. The result of these three flows is the net output of the extruder. The equation is:

$$Q = Q_D - Q_P - Q_L \qquad \text{(Eq. 1)}$$

In most melt screws it is safe to neglect the leakage flow, Q_L, as a small fraction of the net.

The drag flow and pressure flow

Fig. 1: In the extrusion process softened plastic is forced by revolving screw through heated barrel and out of die



are functions of the screw dimensions and speed, and pressure flow depends also upon the melt viscosity and, of course, the pressure developed.

$$Q = AN - B\frac{\Delta P}{\mu}$$

$$= \frac{\pi^2 D^2 N h \sin \phi \cos \phi}{2}$$

$$- \frac{\pi D h^3 \sin^2 \phi}{12 L} \frac{\Delta P}{\mu} \qquad \text{(Eq. 2)}$$

where D = the average diameter of the screw = the major diameter minus the thread depth, h, inches.

N = the screw speed, rev./seconds.

L = the axial length of the melt zone, inches.

μ = the melt viscosity appropriate to the operating conditions, lb., sec./sq. inch.

ϕ = the lead angle of the screw. A lead distance of one diameter corresponds to a lead angle of about 18°.

ΔP = the total rise in pressure (= pressure at the die), p.s.i.

A and B are lumped constants.

The flow through the die is also a pressure flow and must be equal to Q, since that is the output of the extruder. No matter what the shape of the die is, the discharge through it can be characterized by the equation:

$$Q = k \frac{\Delta P}{\mu} \qquad \text{(Eq. 3)}$$

where k = the die resistance, the value of which will depend on its dimensions, cu. inches.

If Eqs. 2 and 3 are combined, the pressure and viscosity are eliminated. It is clear that considering the extruder as a whole, the output depends only on the screw speed and the various dimensions of screw and die, and not on melt viscosity or pressure developed!

$$Q = \frac{AN}{1 + B/k} \qquad \text{(Eq. 4)}$$

For any particular screw and die, therefore, a plot of Q versus N (operating characteristics) should be a straight line. Such plots, obtained from a 2 in.-dia. screw pumping heavy sirup through three different dies, are shown in Fig. 2, above.

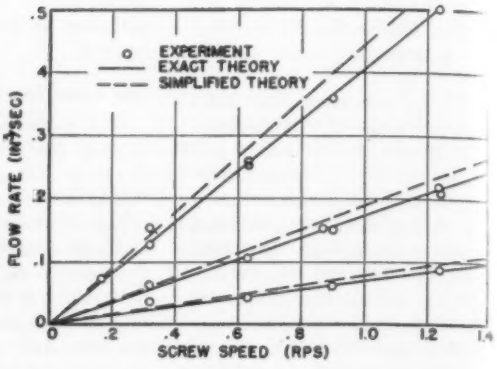


Fig. 2: Operating characteristics for 2-in. screw with three dies, having k values of 1.23, 3.12, and 11.87 × 10^6 cu. in., from top to bottom. The simplified theory gives slightly high values, though leakage was included in the calculations

Screw design

Many assumptions and approximations were made in developing these equations. Equation 4, especially, depends on an assumption that the melt viscosity is the same in the die as in the screw. Since ordinarily the shear rates at these points are different, and since plastic melt viscosities depend on the shear rate, this assumption will not usually be fulfilled. A striking example of how much difference this can make appeared in Ref. 4; however, Eq. 4 serves as a useful guide in spite of its limitations.

The theory also shows how the regulatory characteristics of a metering screw depend on the dimensions. We can summarize thus: regulation is best in screws having small lead angles, shallow threads, and long lengths; unfortunately the output goes down as thread depth or lead angle is reduced (see Eq. 2). A good compromise range for lead angle is from 15 to 25°. It turns out (11) that the same range is useful in the feed zone to achieve good feed rates. It becomes convenient, then, to maintain a constant lead angle over the whole length of the screw and to achieve compression by reduction of thread depth. This type of design also simplifies the machining and reduces manufacturing cost of the screw. In cases where extremely high compression ratios are needed, a combination reduction may have to be used in order to get reasonable output.

At present, the type screw recommended for extrusion of acrylics, nylons, and polyethylene (see pp. 709, 717, and 732) seems to be doing a good job. It will probably serve for most thermoplastics. The present design procedure is to design the melt section (metering zone) according to the abovementioned theory. The feed zone is then made slightly more than ample to accommodate the change in density. The solids feeding theory provides confirmation of its capacity. Measurements made by the authors of that theory show that bulk densities of feeds measured *in the screw* are considerably less than in shipping containers, a fact not generally appreciated. It is the density of the feed in the screw that should be used in calculating the needed compression.

Power requirements

The shearing of viscous materials takes work, and this work appears as heat generated throughout the material. Those areas where shearing is most rapid generally heat up the most. In an extruder the shear rate is fairly uniform, so the turning of the screw generates heat that is distributed evenly through the melt. By the time the melt reaches the metering zone, however, its viscosity has fallen to a level at which the amount of work required to shear the melt is only a small fraction of the total screw horsepower.

Up to the present, no equations have been developed for the work done in the feed section, (though they should be derivable from the feeding equations), and the detailed mechanism of the plasticating zone is not understood. But a simple heat balance sheds much light on power requirements. The feed enters, say, at room temperature (70° F.), and leaves the die at some higher temperature, say 370° F. If its average heat capac-

y over that range is 0.5 B.t.u./lb., °F., and its heat of fusion is, say, 15 B.t.u./lb., °F., then a total of $300 \times 0.5 + 15 = 165$ B.t.u. (or about 0.065 hp.-hr.) must be supplied to extrude each pound of plastic.

A fair rule of thumb to use is this: for every 10 lb./hr. of output capacity, about 1 hp. will have to be supplied by drive and heaters. Some of this can be supplied by preheating the feed, with substantial increases in output and quality (12). This energy may be transferred as heat through the barrel (and screw) or may be provided through mechanical working of the plastic by the screw. Because plastics are poor conductors of heat, very high rates of heat transfer can be realized in extruders only if very high barrel temperatures and/or very long barrels are used. On the other hand, mechanical working supplies the energy evenly at the existing temperature level, thus tending to produce a homogeneous and undegraded melt.

Adiabatic extrusion

In engineering thermodynamics, a sharp distinction is made between heat as such, and work, even though the two are in many ways equivalent. A system, such as an extruder's contents, that neither gives off nor receives heat, as heat, is said to be *adiabatic*. A well-insulated extruder can be made to operate adiabatically (23), but at some sacrifice of versatility.

The custom extruder usually will want to do a large fraction of his heating by mechanical working, using the barrel heaters for final adjustment of conditions. A versatile extrusion setup will also provide for cooling the barrel and perhaps the screw. Improvements in quality have been realized by cooling the screw (2), but at a sacrifice of rate: freezing-out of the melt on the root of the screw in the metering zone reduces the effective thread depth. This may result in better homogenizing, but it definitely cuts down the drag flow. A completely adiabatic extruder becomes especially attractive to the man using it day after day for the same job: once it is designed properly and set up, the operation practically controls itself. The equipment can be quite simple.

Die design

The die is the focal point of the extruder. Here, the melt is forced into something closely approximating its final shape. As has already been mentioned, dimensional uniformity requires the precise metering that is achieved by proper screw design and intelligent operation. Because plastic melts exhibit delayed elasticity (memory), the extrudate cross-section will not be geometrically congruent or even similar to the shape of the orifice, except in the simpler cases (wire-coatings, rods, sheets). This melt elasticity has not been investigated thoroughly enough to reduce die design to a science, but some strides have been made. Laboratory flow data can certainly be used to design dies of simpler shape and to design the screws that are to be used with them. As Eq. 4 demonstrates, the two are intimately associated.

In recent years a number of good articles have appeared on die design. One who is deeply interested in the subject must delve into the field of rheology, and many useful articles on flow properties can be found in back issues of Modern Plastics, Journal of Applied Physics, Journal of Colloid Science, Journal of Polymer Science, Industrial and Engineering Chemistry, and others.

The simplest dies are the spaghetti dies used in making molding powder. Here the laboratory extrusion rheometry applies nicely, and no tight dimensional requirements need be met. Dies for rod extrusion are similar in principle, but usually there are more or less stringent tolerances on extrudate diameter. Pipe dies are more difficult, since both wall thickness and diameter must be controlled, and surface finish is important. In rod and pipe extrusions, the problem of swelling of the extrudate, because of elasticity, is taken care of by having positive take-off devices draw down the extrudate to the desired finished diameter while it is being quenched. Once quenched, swelling ceases. The same technique, basically, is used in monofilament and film extrusion. In extruding pipe, the land length is many times the width of the annular opening, a factor of 30 to 50 being reported as optimum (9). Control of wall thickness increases in difficulty as wall thickness decreases. An effective die design for thin-walled tubing is really two dies in one—the forming die followed by a closely coupled chilling die (34).

The design of cross-head sheeting dies has been discussed in Reference 8, taking into account the non-Newtonian character of plastic melt flow. The principal problem in sheeting manufacture is variation in thickness across the width of the film and in this article equations are given for achieving any desired degree of uniformity by choosing the critical die dimensions on the basis of the melt behavior. K. E. Robbins (18) and H. O. Corbett (22) emphasize the importance of making dies and die fixtures versatile and interchangeable. Robbins also introduced the dam-type sheeting die, a die in which a wide range of thicknesses can be made. An adjustable "dam" behind the die lips provides pressure compensation over a range of flow rates.

It has been shown that if the melt is forced through the die too strenuously, the shear stress may exceed a critical value, about 100 p.s.i., and the extrudate will become rough (15). If the stress is increased even more, the extrudate will tear, even to the point of fragmentation. Much higher rates can be realized if the approach to the constricted die lips is streamlined, (but even then there is a limit beyond which roughness sets in). Streamlining helps not only to prevent roughness, but also helps to prevent melt from "hanging up" in the die. Dead spots in the die eventually become filled with severely degraded polymer that can ruin the product. Vinyls are particularly sensitive in this respect.

Some years ago Fisher pointed out that cross-head extrusion dies, originally developed for wire coating, offer the versatility needed for some interesting special effects (32). Multi-color extrusions can be made by hooking

two or more extruders up to one die. In similar fashion, polyethylene-lined vinyl tubing was extruded in one step. An interrupter in the die permits extrusion of ribbed tubing. And so on. Fisher gives construction details.

Die design recommendations for individual resins will be found in the articles beginning on p. 709 which cover specific materials.

Mixing

Extruders are often used to mix colors, stabilizers, and fillers into the resin. While not as effective for this purpose as intensive (Banbury) mixers, they often serve adequately. Years ago, it was thought that by extending the screw shaft in a long smooth nose or "torpedo" fitting closely in the barrel, dispersion of color particles would be improved. It is now known that the shear stresses attained are not nearly high enough to disperse pigment particle aggregates. However, the long, thin annulus surrounding the torpedo offers tremendous resistance to the discharge of the screws. This means more back flow and more total shear, resulting in better mixing. This added resistance increases the effective length of the melt zone and improves regulation, but with an output penalty. Packs of screens placed in the die before the lips have been used for the same purpose. Today it is recognized that proper design of the metering zone and die eliminates the need for additional front-end resistance. For the purpose of improved mixing, however, a new, helically grooved torpedo has been announced (1). This has the advantage of not offering much restriction while doing a good job of subdividing and recombining the melt stream.

In two papers presented at the Miami meeting of the ACS in April, 1956, criteria for mixing in shear were proposed and equations giving the amount of shear accomplished in an extruder were presented.

These papers, to be published in Industrial and Engineering Chemistry, should provide impetus for some new designs of mixing screws for single-screw extruders.

Multi-screw extruders have long been used for compounding. Recent correspondence (10, 5) indicates there is still much divergence of opinion on their relative merits as compared with single-screw machines. Types having intermeshing screws approach positive-displacement pumps in their metering characteristics, however, and from the regulation standpoint they are excellent.

Recently M. S. Frenkel proposed the "imposed-order" extruder (14), a fancy machine designed for efficient mixing in which the screw diameter (both root and major) alternately increases and decreases. Both barrel and screw have flights. This machine, on which patents have been granted, should do much to stir up thinking on extrusion-mixing.

Extraction-extrusion

Many molding powders contain residual volatiles—water, monomer, solvents—which will cause bubbles, surface roughness, and distortion if not removed before extrusion. One way to do this is to dry them in an oven or hopper-dryer, incidentally realizing the advantages of preheating (12). A second approach is to build the extruder with a vented zone where the volatiles can be flashed off after the plastic has been melted and brought to a temperature well above the normal boiling point of the unwanted volatile matter. The vent may simply be open to the air, or a vacuum may be applied to speed things up and to keep the vapors out of the working area. In most such extruders and in the vacuum screw proposed by Bernhardt (13), the vented zone is rather short, but adequate for removal of up to 5% volatiles from the feed.

The vented screw can be adapted to any extruder with a sufficiently long barrel ($L/D = 18+$), and is by far the cheapest method of venting for an operator who already has an extruder. Careful attention must be paid to the design of the different screw sections.

The twin-screw extractor-extruder of Welding Engineers can have a very long vented zone and is capable of turning out a dry product (bubble-free) even from slurry feeds containing less than 50% solids.

Instrumentation

In years past, extrusion was accomplished without benefit of any but the crudest instrumentation. Today, increasing competition requires high productivity. Good instrumentation not only saves man-hours, but eliminates man-errors. The standard modern extruder is provided with 3-zone heating and cooling, and appropriate controllers. For the sake of knowing what is going on in the extruder, it is wise to have thermocouples in both the melt in the die and the die metal (17). A melt pressure gage (26, 19) in the die is a good indicator of rate fluctuations, and its signal output can be fed into a speed controller. Closer control is the trend in extrusion, as in injection molding.

References

This list is not intended to be exhaustive, but every reference is informative on some phase of extrusion.

1. Collins, F. H., "The mixing torpedo," SPE J. *13*, 43, May 1957.
2. Maddock, B. H., "Factors affecting quality in polyethylene extrusion," MODERN PLASTICS *34*, 123, April 1957.
3. Nordgren, J. E., "Continuous winding machinery for plastic film and sheeting," SPE J. *13*, 23, April 1957.
4. Bernhardt, E. C. "Valved extrusion," SPE J. *12*, 17, Feb. 1957.
5. Hogan, E. F., "Doub'e-screw vs. single-screw extruders," SPE J. *12*, 47, Dec. 1956.
6. Maddock, B. H., "Fundamental mechanisms in polyethylene extrusion," SPE J. *12*, 49, Oct. 1956 and 50, Nov. 1956.
7. Gaspar, E., "Problems and trends in European extruder design," SPE J. *12*, 23, Oct. 1956.
8. "Design and operation of cross-head sheeting dies," MODERN PLASTICS *33*, 127, Aug. 1956.
9. Perkins, R. S., "Extrusion dies for plastic pipe," SPE J. *12*, 47, Aug. 1956.
10. Gaspar, E., "Single and double screw extruders," SPE J. *12*, 43, July 1956.
11. Darnell, W. H. and Mol, E. A. J., "Solids conveying in ex-

truders," SPE J. *12*, 20, Apr. 1956.

12. Wilton, P. and Marrow, F. D., "Preheating polyethylene prior to extrusion," Plastics Tech. *2*, 159, Mar. 1956.

13. Bernhardt, E. C., "The vacuum extruder screw," SPE J. *12*, 40, Mar. 1956.

14. Frenkel, M.S., "Continuous 'imposed-order' mixer-extruder with complementary adjustability," Brit. Plastics *29*, 62 and 98, Feb. and Mar. 1956.

15. Tordella, J. P., "Melt fracture—extrudate roughness in plastics extrusion," SPE J. *12*, 36, Feb. 1956.

16. Bernhardt, E. C., "Is adiabatic extrusion practical?" SPE J. *12*, 48, Feb. 1956.

17. Underwood, M., "The importance of temperature measurement in the extrusion die," SPE J. *12*, 43, Jan. 1956.

18. Robbins, K. E., "Extrusion dies and take-off equipment," MODERN PLASTICS *33*, 125, Dec. 1955.

19. Bernhardt, E. C., "Stock thermocouples, pressure gauges, and rupture disks for use on plastics extruders," SPE J. *11*, 25, Nov. 1955.

20. Kennaway, A., "The granulation of polythene," Brit. Plastics *28*, 18, Jan. 1955.

21. Carley, J. F., "Flow of melts in "cross-head"-slit dies; criteria for die design," J. Appl. Physics *25*, 1118-23, Sept. 1954.

22. Corbett, H. O., "A new look at extrusion," MODERN PLASTICS *31*, 198, June 1954; "Extrusion die design," SPE J. *10*, 17, June 1954.

23. McKelvey, J. M. and Bernhardt, E. C., "Adiabatic extrusion of polyethylene, " SPE J. *10*, 22-30, Mar. 1954.

24. McKelvey, J. M., "Analysis of adiabatic plastics extrusion," Ind. & Eng. Chem. *46*, 660-4, 1954.

25. Carley, J. F. and McKelvey, J. M, et al., "Symposium on the theory of plastics extrusion," Ind. & Eng. Chem. *45*, 969-93, May 1953.

26. Carley, J. F., "Modified Bourdon gage for measuring pressure in polymer processing equipment," Ind. & Eng. Chem. *45*, 858, April 1953.

27. Atkinson and Owen, Plastics Inst. (London) Trans. *21*, No. 44, 40-60, April 1953.

28. Gore, W. L., "Principles of plastics extrusion," SPE J. *9*, Mar. 1953.

29. Carley, J. F., "Operating characteristics of extruders," SPE J. *9*, Mar. 1953.

30. McKelvey, J. M., "Design of screws for polyethylene extrusion," SPE J. *9*, Mar. 1953.

31. Simonds, H. R., Weith, A. J., and Schack, W., "Extrusion of plastics, rubber, and metals," Reinhold, New York, 1952.

32. Fisher, E. G., "Cross-head extrusion of thermoplastics," MODERN PLASTICS *27*, 83, May 1950.

33. Purday, H. F. P., "An introduction to the mechanics of viscous flow," Dover Publications, New York, 1949. (Also published as "Streamline flow," Constable and Co., London, 1950.)

34. Jargstorff, G. and Joslin, C., "Dimensional control in extruded tubing," MODERN PLASTICS *26*, 191, Sept. 1948.

35. Decker, H., "Die Spritzmaschine," P. Troester, Hanover, Germany, 1941.

36. Rowell, H. W. and Finlayson, D., "Screw viscosity pumps," Engineering *114*, 606, Nov. 1922; *126*, 249, 385, 1928.

EXTRUSION OF ACRYLICS

BY C. P. MacDERMOTT*

Extrusion of acrylics into sheets, contour shapes, and rods is taking on increasing importance. Techniques for extruding the three types vary somewhat (see Table I, p. 710).

Extrusion of sheeting

A significant portion of acrylic resins is extruded into flat sheeting to be used either for glazing, for postforming into outdoor signs and displays, or other applications. Whatever the application, however, it is highly desirable to produce sheeting that is: 1) shrink-free; 2) uniformly thick; 3) glossy; and 4) free of surface defects. These properties can be readily obtained by the use of the proper extrusion and take-off techniques.

Shrink-free sheeting

For practical purposes, shrink-free sheet may be defined as that having less than 0.5% shrinkage in either the machine or transverse direction when subjected to the normal heating cycles used during postforming operations. Such extruded sheeting must be prepared by using the least possible amount of draw down. This may be accomplished by allowing the extrudate to sag vertically ½ to 1 in. in the 3 to 5 in. horizontal span between the die lips and the take-off equipment.

The advantages to be obtained by the lack of inherent shrinkage in the acrylic sheeting are: improved uniformity of thickness in the postformed shape and increased resistance to impact and solvent stress crack.

Uniform thickness

During a run, random spot checks on thickness should show no more variation than ± 5% for sheeting from 40 to 200 mils thick. The variation may be either across the sheet or in the machine direction. However, with proper attention to screw design and extrusion temperatures, the caliper variation in the machine direction is usually not significant. With transverse uniformity, on the other hand, additional precautions are necessary to prevent large deviations in the thickness of the sheeting.

Assuming that the die opening has been set to produce the nominal thickness wanted, the caliper variation across the sheet can be checked by observation of the extrudate as it leaves the die. This is true providing the sag recommended for shrinkage control is maintained. As long as the sag across the entire sheet is uniform, acceptable uniformity of thickness can normally be expected in the finished sheet.

If the sag is not uniform in one or two areas across the sheet, it is frequently possible to make corrections by adjusting the zone temperatures in the die. Since the viscosity of acrylic resins varies sharply with temperature, these adjustments must be made carefully or over-control may re-

* Sales Div., Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

TABLE I: Extrusion of acrylics

	Sheeting	*Shapes*	*Rods*
A) Machine characteristics			
Diameter, in., of screw needed to deliver at 60 r.p.m.			
50 lb./hr.	2	2	2
150 lb./hr.	3¼	3¼	3¼
500 lb./hr.	6	6	6
Recommended L/D	20:1	20:1	20:1
Recommended screw type	Metering, rapid compression, constant pitch		
Compression ratio [1]	3:1	3:1	3:1
Depth of feed zone in 150 lb./hr. screw, in.	0.440	0.440	0.440
Lead ratio [2]	1:1	1:1	1:1
Screen pack, mesh numbers in direction of flow	None	None	None
Drive power for 150 lb./hr., hp.	30	30	30
B) Operating conditions			
Melt temperature at die, °F.			
General purpose A.S.T.M. type 6	395-430	395-430	395-430
Heat-resistant A.S.T.M. type 8	420-490	420-490	420-490
Approx. melt pressure at die, p.s.i	100-200	200-400	40-100
Screw cooling	Unnecessary	Unnecessary	Unnecessary
Feed preheating (see p. 711 for information on Predrying)	Depends on need for drying.	Depends on need for drying.	Depends on need for drying.
Entering temperature, °F.	RT to 175°F.	RT to 175°F.	RT to 175°F.
Metal temperatures, °F.			
General-purpose type			
Rear cylinder	350-360	350-360	350-360
Halfway along cylinder	380-390	380-390	380-390
Forward cylinder	390-400	390-400	380-390
Die	390-400	390-400	380-390
Heat-resistant type			
Rear cylinder	400-410	370-380	370-380
Halfway along cylinder	430-440	410-420	410-420
Forward cylinder	430-440	420-430	420-430
Die	430-440	420-430	420-430
Is extrudate water quenched?	No	No	Rarely
Water temp. °F.	—	—	80-100
Air gap, in.	—	—	10-20
Time in water, sec.	—	—	10-20
Draw ratio [3]	1:1	1:1	1:1

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns on same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

sult. For example, the viscosity increases by about 100% when the melt temperature is decreased from 420 to 400° F. An increase in viscosity of the extrudate in any one area across the die will cause that portion of the extrudate to be drawn down to a thickness appreciably less than the remainder of the sheet. A similar decrease in viscosity may cause localized sagging to such an extent as to interfere with the normal take-off procedure.

If an appreciable error has been made in setting the die opening at some point across the die it is unlikely that compensation for the error can be made by changing the die temperature at that point. Adjustments are then required to correct the die opening. These can be made while operating by changing the setting until uniform sag is obtained.

Surface Imperfections

For many applications of extruded acrylic sheeting, it is desirable to have a product that is sparkling clear, with good gloss and without die lines or surface blemishes. To obtain these features, reasonable care in the preparation of the die prior to extrusion should be used. Imperfections in the sheet can be avoided by proper machine operation.

Die lines: The following suggestions are made to prevent the formation of "die lines" (continuous scratch-like lines formed along the surface of the sheeting in its machine direction):

1) The die lands must be pol-

ed to a very high (No. 4) finish, and the die opening setting made without marring the finish. To minimize accidental marring of the finish, it is recommended that the lands be made of a hard steel and then chrome-plated.

2) All of the inside surfaces of the manifold-type die should be polished to at least a No. 10 finish and then chrome-plated. Extreme care must be exercised so as not to mar these surfaces. Because of the unusually long "plastic memory" of the acrylics, a disturbance set up in the melt flowing through the die manifold may remain and appear as a die line even after passage through the die slot and die lands.

3) Care must be taken to prevent contamination of the resin as it is fed to the extruder, since foreign particles may hang up in the die opening and cause die lines. Drums and hoppers should be kept covered during extrusion.

4) The melt temperature of the acrylics in the die should be carefully controlled to minimize die lines. If the temperature is on the low side of the normal extrusion range, the sensitivity of the extrudate to die lines is greatly magnified. If the temperature is too high, incipient "boiling" at the die land is frequently encountered, causing surface bubbles that resemble die lines. As far as the effect of temperature on the severity of die lines is concerned, it is best to maintain the melt temperature as high as possible without encountering the "incipient boiling."

It is in this area of extrusion that the new high-heat distortion acrylics (e.g., Lucite 140[1] acrylic resin) are advantageous. The unusually high upper extrusion temperatures of these materials makes it possible to operate in the range of 470 to 490° F., a point high enough to cause all but the most severe die lines to "flow out" and disappear from the surface of the sheeting.

Other surface imperfections: Surface imperfections other than die lines may, of course, be due to a number of things. One of the more obvious and most frequently encountered is contamination of the resin either prior to extrusion or as it comes from the die. When this contamination consists of very fine, dust-like particles, the result is myriads of small sinks or dimples in the sheeting that are more noticeable than the particles themselves. Such contamination can also be obtained during regrind operations, and it is highly advantageous to do the regrinding in a clean, dust-free area.

[1] Trademark E. I. du Pont de Nemours & Co., Inc.

Take-off technique

Acrylic sheeting is best extruded using an air quench, and quite a bit of latitude is permissible with the design of the take-off equipment. However, adherence to a few basic principles in take-off technique will result in a product having optimum physical properties and appearance.

The first part of the take-off to come in contact with the hot extrudate frequently consists of a series of rolls, or simply pipes, spaced about 1 in. apart and perpendicular to the direction of extrudate flow. The surface temperature of the rolls making up the first 2 to 3 ft. of the over-all 10 to 20 ft. length of the take-off equipment should be maintained within the range of 100 to 130° F. If the temperature is held much below 100° F., "freeze off" lines across the sheeting are formed. In addition, the sudden quenching tends to magnify the size of sinks or dimples manifested as surface imperfections. If the surface temperature is allowed to go much above 130° F. the sheeting starts to stick to the rolls, resulting either in lines across the sheeting or, if too hot, a complete stoppage of sheeting movement.

In addition to the temperature of the rolls, their surface condition must also be considered. They must be absolutely free of any dirt, grit, or surface imperfections that would cause scratching of the sheeting as it is drawn across the rolls. These scratches have much the same appearance as die lines, although an experienced operator can tell the difference.

Acrylic rod extrusion

In the extrusion of acrylic sheeting, the length of the die land is relatively unimportant, since it is possible with the manifold-type die to produce good sheeting whether the die land is $\frac{1}{16}$ or 2 in. long. The land length assumes a greater importance in forming a good rod, however, and it has been found that a ratio of the land length to rod diameter should be about 7:1 to 10:1. As in the case of sheeting, the inside surface of the rod die must be highly polished to prevent die lines.

There are a number of designs for rod take-off equipment, but the one most widely used consists of a long series of rollers sized to ½ the diameter of the rod being made. The length of the conveyor system is governed by the cooling time necessary to produce a rod that can be handled without bending. The rollers are set at a slight angle to the forward travel of the rod, causing the rod to turn slowly. This constant turning helps considerably in maintaining roundness. In a few instances, a water quench has been used successfully to speed up the cooling process and to provide a hardened "skin" which aids in holding concentricity.

The problem of bubble formation in extruded rod exists to a degree not encountered in sheet extrusion. This is due to the greater thicknesses involved. The vented barrel (with vacuum assist) or the vacuum screw are particularly advantageous in conjunction with rod extrusion, since they will eliminate most causes of bubble formation. The new high-heat distortion Lucite 140 acrylic resin also performs well in rod extrusion even without the devolatizing equipment, since it has a low volatile content.

General extrusion techniques

Melt temperatures: If the melt in the extruder is kept hot too long it degrades, and the extrudate suffers from discoloration, poor surface, etc. The normal melt temperature during extrusion may be considered to be the top safe temperature for a hold-up period of 5 minutes.

Predrying: The equilibrium moisture content of methacrylates at 50% relative humidity and 70° F. is about 0.6 percent. For this reason, the powder should be

dried prior to extrusion regardless of exposure after opening the shipping container. A moisture content of about 0.1% or less is optimum.

A circulating-air oven is adequate for drying. The drying time, of course, depends upon a number of variables, such as original moisture content, relative humidity of air prior to drying, etc. When in doubt, however, a drying period of at least 8 hr. at 175° F. is recommended. A hopper drier set up to give the same amount of drying is also adequate.

Venting of extruder: Drying of the resin may be omitted if a vented extruder is used. A vented extruder will ordinarily operate very satisfactorily on acrylics, and is desirable for many acrylic extrusions in that it will assure an extrudate free of internal bubbles. This is particularly advantageo for rod extrusion.

Barrel, screw, and dies: Sin the decomposition products acrylic resins are not corrosiv a good grade of tool steel is ad quate for the dies. For high fini and longer wear, sometimes th dies are chrome-plated. Barre and screws may be made of con ventional extrusion machine ma terials.

EXTRUSION OF TRIFLUOROCHLOROETHYLENE (TFCE)

BY J. A. JUPA*

Trifluorochloroethylene is a versatile thermoplastic with an unusual combination of outstanding physical and chemical properties. It is a high polymer of trifluorochloroethylene (hereinafter called TFCE) which can be used at temperatures up to 392° F. and as low as −320° F. The material is nonflammable and possesses excellent weathering resistance, zero moisture absorption, toughness, transparency, excellent electrical properties, fungus resistance, and chemical inertness. Molding materials are supplied in the form of plasticized and unplasticized powders. These molding powders for extrusion purposes exist in the form of high-density granules or pellets (60 lb./cu. ft.) or low-density powder (19 lb./cu. ft.). Although both high- and low-density powders can be used for extrusion work, most molding powders are identified by grade numbers, e.g., Kel-F[1] 270, 300, and 500. Where greater flexibility is desired, plasticized material, e.g., Kel-F grade 300 P-25, is most commonly used; the amount of plasticizer could be varied to suit the application.

Type of equipment

Certain general requirements have been set up for extruding TFCE (see Table I, p. 713). More specific details are discussed below.

TFCE has been extruded on most of the commercially manufactured machines. Minor machine modifications specific to TFCE might be necessary to insure high quality of extruded products. For the most part, electrically-heated extruders are used which are able to maintain uniform temperatures between 300 and 675° F. The maintenance of the uniform temperature is most important since the character of the profile is dictated by its thermal history within the extruder. A system of heat control which maintains a constant balance between the heat lost to the plastic melt and the heat introduced by the heating system, would approach ideal operating conditions. The temperature fluctuations should be kept to a minimum in the range of ± 2° F. along the length of the barrel and die. It is particularly important to keep the die temperature constant. An excess of 10° F. at the die can cause excessive material breakdown while a drop of 10° F. gives satisfactory material.

The contact surfaces of the barrel can be Xaloy 306, high chrome-nickel, stainless steel, Duranickel, or chromium-plated steel.

With the exception of Xaloy 306, the contact surfaces for screws should be the same as discussed above for extruder barrel surfaces. Two types of screws have been found to be satisfactory—the conventional full-flighted screws having uniform pitch and increasing root diameter and the metering-type screw with uniform pitch and increasing root diameter.

Compression ratios of 1½ and 2½ to 1, have been most commonly used. The contact surfaces should be smooth and highly polished with a radial clearance of 0.005 in. or less. Provision should be made to keep the hopper zone in the screw area relatively cool. This may be done with air or water. Excessive cooling in this area will place an unnecessary load on the drive mechanism and most likely be accompanied by "squealing."

Excessive heat in the hopper zone will result in premature melting of the TFCE molding powder and be manifested by loss of feed and bridging of the molding powder in the hopper. The hopper should be made of stainless steel or chromium-plated steel to prevent discoloration of extruded profile.

Extrusion rates of TFCE materials are lower than most common types of thermoplastics and lower screw speeds are necessary. Therefore, provisions for screw speeds between 3 and approximately 30 r.p.m. should be considered. Screens are not usually necessary for extrusion of TFCE. However, to minimize the effect of surging and for more complete dispersion of color concentrates, a breaker plate with ⅛-in. holes and screens between 40 and 100 mesh have been successfully employed.

Die design

The materials of construction of the die are similar to those recommended above for the barrel of the extruder with the exception of Xaloy 306. For many rod and tube applications, die dimensions approximately 10 to 15% greater than the nominal size will be satisfactory. This should result in extrusions that have a low degree

* Minnesota Mining and Mfg. Co., St. Paul, Minn.

[1] Kel-F is a registered trademark of the Minnesota Mining and Mfg. Co. TFCE is also made by Bakelite Div. of Union Carbide Corp. under the trade name "Bakelite."

strain. However, for increased production rates, less critical control problems, and in cases where the higher degree of strain is desired, the drawdown ratio can be scaled up accordingly. The most commonly used drawdown ratio is 3 to 1. Drawdown ratios as high as 12 to 1 have been used for certain types of work. Figure 3, p. 714, shows a straight in-line tubing die; some suggested die dimensions for tubing are contained in Table II, p. 715. To maintain optimum properties in the final extruded piece, the highest temperatures should be concentrated at the exit portion of the die. This is accomplished by extending the die bushing 1 to 4 in. between the die head and using a band heater on this bushing to control the heat independently. It is most important to have very accurate and uniform control of the die temperatures. A minimum number of "spider" legs should be used.

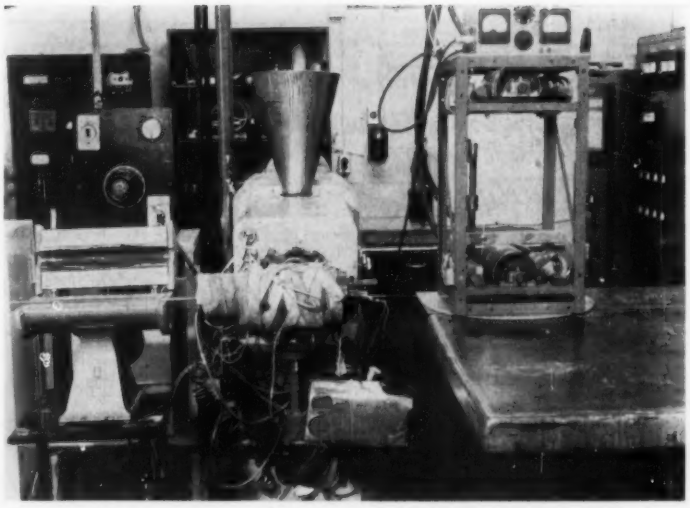


Fig. 1: Manner in which die is mounted in machine and wire heating and cone heating devices are shown in setup above

Wire insulation

The high-melt viscosity of TFCE requires the use of tube-on techniques, rather than the conventional pressure type extrusion methods used on vinyls and other more highly plasticized thermoplastics. The use of the tube-on techniques eliminates the restrictive effect of small die sizes. In this way the die sizes can be increased appreciably and the oversized tube is drawn down onto the wire as it leaves the die.

Considerable progress has been made within the last year on the die design most suitable for wire insulation with TFCE and also some basic principles have been established. Figure 2, p. 714,

TABLE I: Extrusion of trifluorochloroethylene

A) *Machine characteristics*	*Sheeting*	*Wire coating*	*Shapes*	*Pipe*
Recommended L/D	(25+16):1	(25—16):1	(25—16):1	(25—16):1
Recommended screw type	Metering and conventional	Metering and conventional	Metering and conventional	Metering and conventional
Compression ratio[1]	2:1	2:1	2:1	2:1
Lead ratio[2]	1:1	1:1	1:1	1:1
Screen pack, mesh numbers in direction of flow	40,60,100	40,60,100	40,60,100	—
B) *Operating conditions*				
Melt temperature at die, °F.	580-590	580-590	580-590	580-590
Approx. melt pressure at die, p.s.i.	2000-3000	2000-3000	2000-3000	2000-3000
Screw cooling medium	air	air	air	air
Feed preheating	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Metal temperatures, °F.				
Rear cylinder	400-450	400-450	400-450	400-450
Halfway along cylinder	450-475	450-475	450-475	450-475
Forward cylinder	500-550	500-550	500-550	500-550
Die	550-650	550-650	550-650	550-650
Is extrudate water quenched?	Yes	Yes	Yes	Yes
Water temp., °F.	50-70	50-70	50-70	50-70
Air gap, in.	2-10	2-10	2-10	2-10
Time in water, sec.	30-60	30-60	30-60	30-60
Draw ratio[3]	Variable	Variable	Variable	Variable

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

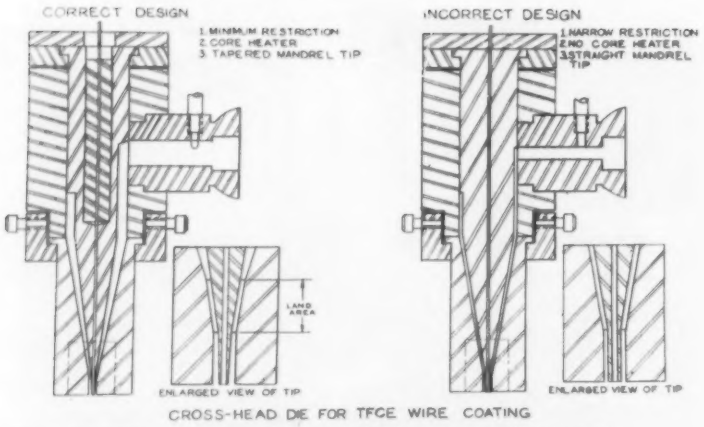


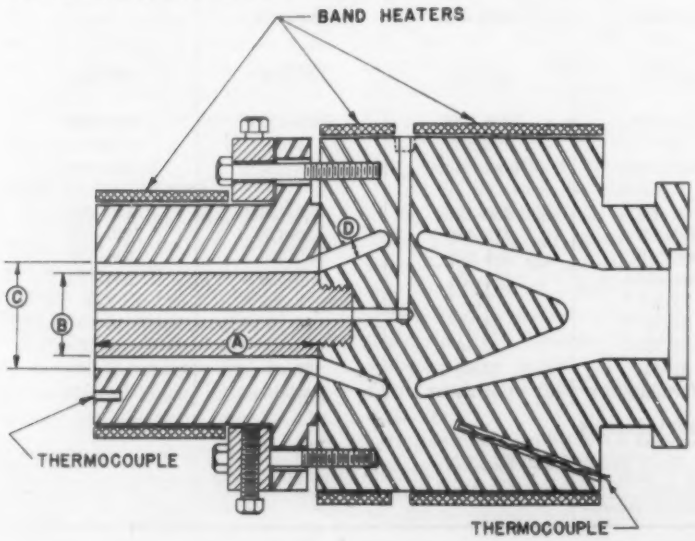
Fig. 2: Comparison of correct and incorrect design for cross-head die to be used for extruding trifluorochloroethylene wire coating

shows correct and incorrect designs. The correct design stresses the minimum restriction to flow within the die to the land area. This allows the use of maximum pressure within the die and the positive movement of material. An enlarged view of the tip shows the land area has been moved back along the mandrel for a short distance and the guider itself has been tapered. The die bushing essentially leaves the land area in a straight line. The use of a tapered tip shortens the length of the cone leaving the die, giving improved centering and lower shrinkage or strain. The use of an internal or core heater is recommended wherever possible. This allows the over-all temperature of the plastic melt to be reduced and minimizes the effect of material breakdown. However, satisfactory work has been done with and without the use of an internal heater.

In the past, vertical extrusion has been recommended. Using the new die design, a shorter plastic cone is obtained and horizontal extrusion is possible. Horizontal techniques fit in with most existing wire insulating setups. For horizontal wire coating, there has been added a device on the entrance side of the die which would maintain the wire temperature close to that of the TFCE plastic leaving the die and a furnace on the exit side of the die to permit normal shrinkage above the transition point (417° F.). The use of a wire heater should not be overlooked. Formerly, minimum quench distances were recommended; that is, it was recommended that the wire be quickly quenched in water as soon as possible after leaving the die. More recent work has shown that a quench distance of three feet or possibly more, results in lower shrinkage on the wire. The lower shrinkage, a maximum shrinkage of 45% or less, does not develop flareback when tested according to the solder-dip test of MIL-W-16878.

All other accessory equipment such as pay-off capstan, spark-tester, and takeup are of conventional design. Figure 1, p. 713, shows the manner in which the die is mounted in the machine and the wire heating and cone heating devices.

Fig. 3: Straight in-line die is recommended for extruding TFCE when production runs are long. Die dimensions are listed in Table II, p. 715.



Operating temperatures

In the final analysis, the actual temperatures used may be ± 25° F. or thereabouts of the suggested temperatures. It is important to have a reasonable temperature differential between various heating zones so that the controlling effect is of a positive nature. The final temperature settings will be determined by the character of the extruded profile. Excessive temperatures are being used when material develops numerous bubbles. The temperatures are too low when the extruded profile is lumpy, rough, or has a snakeskin appearance. The correct temperatures are attained when the extruded profile is smooth, transparent, and clear after it leaves the die. It is most important to use the lowest practical temperatures. At 500° F. material temperature, TFCE will not develop any significant material breakdown in one to two hours. At a temperature of 550° F. TFCE would not suffer any excessive breakdown within a half hour or less. In the neighborhood of 600° F., significant breakdown could take place within minutes. Therefore, it is important to keep the higher temperatures near the

TABLE II: Suggested die dimensions

	Tube size, O.D. in inches	
	1/16 to 1/2 in.	1/2 to 1 1/4 in.
A*—Land length, in.	1 to 2 in.	2 to 3 in.
B*—Mandrel diameter, O.D.	3 times nominal inside diameter	
C*—Die bushing, I.D.	0.180 to 1.50 in.	1.50 to 3.75 in.

* The letters A, B, and C refer to the same locations of these letters shown in the schematic drawings, Fig. 3, p. 714.

exit portion of the die where the contact time is reduced to a minimum. As indicated above, material breakdown is a function of the time and temperature, that is, the rate of material breakdown increases with temperature and with time at any fixed temperature.

Product quality

TFCE is essentially a crystalline material. The degree of crystallinity can be modified by various heat treatments. Within certain limits, if a clear transparent tube is required, quick quenching in water is recommended; however, if it is desired to increase the rigidity of the tubing, a more crystalline or more slowly cooled medium is suggested. Normally, cooling the extruded profile in air will serve to increase the degree of crystallinity and the general stiffness of the product. However, a subsequent, prolonged heat treatment can induce further crystallinity. Good clarity by quick quenching can be expected in profile thicknesses up to 1/8 in.; beyond this section thickness, the clarity gradually diminishes to a translucent effect.

The useful life of any extruded plastic article is to a great extent a function of its retained or residual molecular weight. Therefore, minimum breakdown in the extrusion process should be considered a desirable goal. The extent of material breakdown during extrusion can be measured with various devices. In the case of TFCE the ZST apparatus has been found very useful as a quality control device. In this device, a prepared test specimen with a double notch at the center is suspended in a constant temperature chamber with a fixed weight suspended from one end. The period of time in seconds required for this specimen to break is a measure of its relative molecular weight. The higher the value in seconds, the higher the molecular weight; the lower the value, the lower the molecular weight. This device will make it possible to maintain uniform quality of extruded products.

EXTRUSION OF CELLULOSICS

BY H. SEGAL*

The family of cellulosics includes cellulose acetate, cellulose propionate, cellulose acetate butyrate, and ethyl cellulose—all of which are extrudable by the methods which are discussed in the following article.

The cellulosics are generally noncorrosive and the extrusion equipment and dies are usually fabricated of steels selected to provide ease of fabrication and serviceability rather than corrosion resistance. Recommended materials of construction are as follows: barrel—any superhard alloy; screw—machine steel with top of flights hard surfaced or with screw heat treated to obtain additional surface hardness; dies —carbon steels or hardenable steels where such materials are desirable.

* Development Project Mgr., Celanese Corp. of America, 200 Ferry St., Newark, N. J. References were prepared by the editors.

Screw design

The screw design shown in Fig. 1, below, has proven suitable for cellulosics extrusion. It has a 1.7:1 compression ratio which is attained by varying the root diameter. With this design it is necessary to provide internal cooling in the screw and a screen pack containing at least one 30-mesh screen to minimize the effects of a tendency for extruder surging, particularly at the higher screw speeds. It is hoped that improved screw design will eliminate the need for these correctives. Higher compression ratios have been used but of themselves have not yielded any benefit. Output rates do fall off as compression ratio is increased.

Extrusion conditions

See Table I, p. 716.

All cellulosics are mildly heat sensitive and require some care in handling. This sensitivity is time–temperature dependent and, accordingly, there is a maximum temperature limit for their processing. The flow path through the gate and die must be streamlined to prevent stagnant areas where thermal degradation would occur.

Flow properties: Cellulosics for extrusion can be manufactured in a wide range of flow properties by varying the formulation. The choice of resin is based on the functional requirements of the end product being manufactured and/or equipment limitations.

Operating temperatures: Figure 2, p. 716, shows the relationship between average extrusion temperatures and flow properties of cellulose acetate. Similar curves could be prepared for the other cellulosics. The minimum operating temperature is a function of the softening point and the maxi-

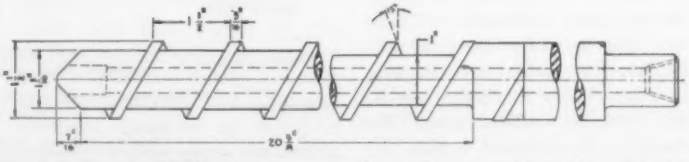


Fig. 1: Sketch of 1.7 compression ratio screw for 1 1/2-in. extruder

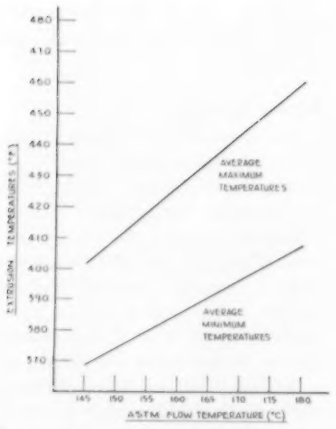


Fig. 2: Relation between acetate extrusion temperatures and A.S.T.M. flow temperatures

mum operating temperature a function of flow properties of the material.

It is very important that the proper operating temperatures are used. These may have to be determined experimentally for each new grade of resin. High temperatures tend to degrade the resin and cause decomposition products which may discolor or disfigure the extruded product. Low temperatures produce poor surface finish and poor physical properties.

Predrying: Since cellulosics absorb moisture, it is necessary to dry the pellets prior to or during extrusion. The latter technique involves the use of a vented extruder which can remove volatiles in the course of extrusion. Regardless of the means employed, the extrudate must not contain over 0.3% water or the product will show surface defects.

There are several acceptable drying methods. These are: tray drying in an oven, belt drying in an oven or under infra-red lamps, continuous rotary-tray drying, and hopper drying. The last method involves a continuous system that forces warm dry air up through a large hopper above the extruder feed section. There are also specially designed extruders that contain devolatilizing sections. These machines can be fed undried pellets since the moisture is removed within the extruder.

Drying time is generally from ¾ to 3 hr. at 140 to 170° F.

Purging routine: Continue extrusion at minimum rates until all temperatures fall approximately 50 to 70° F.

Future development

The principal problems that still face the cellulose plastics extruders, and probable solutions are as follows:

1) *Increased output.* This is important because it allows increased production capacity without the expenditure of additional capital. The solution to this problem probably lies in better screw design, in arriving at optimum operating conditions, and in some cases in better design of take-off equipment which is used with the extruder.

2) *Improved uniformity.* Dimensional variation in extruded cellulose products are partly a function of the variability of the extruder operating condition. In addition, extruder surging with the cellulosics, which is not associated with stability of extruder conditions, is also a factor. There

TABLE I: Extrusion of cellulosics

A. Machine characteristics	
Diameter, in., of screw needed to deliver at 60 r.p.m.:	
50 lb./hr.	2½ regardless of application
150 lb./hr.	3½ regardless of application
400 lb./hr.	4½ regardless of application
Recommended L/D	13:1 = 20:1
Recommended screw type	Either decreasing pitch or decreasing root diameter
Compression ratio[1]	1.7
Depth of feed zone in 150 lb./hr. screw, in.	5/8
Lead ratio[2]	1:1 on decreasing root diameter screw. Variable on decreasing pitch screw
Screen pack, mesh numbers in direction of flow	20, 30, 20, 9
Drive power for 150 lb./hr., hp.	25 hp. (varies as a function of barrel length and specific screw design)
B. Operating conditions	
Melt temperature at die, °F.	This is a function of flow range of the resin being used.
Approx. melt pressure at die, p.s.i.	50 to 200 depending upon die exit restriction
Is screw cooled?	Yes
Medium	Water or water and steam
Temperature of medium, °F. or wattage in 150 lb./hr. screw	Room temperature to 100°F
Is feed preheated?	No—except as might result from drying prior to extrusion (See text on "Predrying," left.)
Metal temperatures, °F.	
Rear cylinder	These all depend on flow range of the particular resin being used.
Halfway along cylinder	
Forward cylinder	
Die	
Is extrudate water quenched?	No
Draw ratio[3]	1:1 = 15:1

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

are many uses for cellulosic products that cannot presently be filled by extruded materials because of the lack of uniformity.

Those conditions which may provide the necessary improvement are more uniform control of screw rotation; cylinder, gate, and die temperatures; melt temperature; take-off equipment speeds; and, again, improved screw design.

3) *Surface improvement.* In addition to gels, other surface deficiencies are die lines, pock marks, and blush. Reduction of these defects may possibly be accomplished by better die design and by further progress in development of take-off and melt cooling equipment.

References

For further information on cellulosic materials, see p. 96; for additional data on extrusion equipment, p. 898.

"Future for plastics pipe," MODERN PLASTICS *31*, 73 (Mar. 1954).

"Continuous extrusion of variegated strip," MODERN PLASTICS *29*, 120 (Apr. 1952).

"Compounding and extruding in one unit," MODERN PLASTICS *26*, 87 (June 1949).

EXTRUSION OF 66 NYLON

BY KAREL G. TOLL*

Nylon is the generic name for a group of thermoplastic materials defined chemically as polyamides. They are characterized generally by extreme toughness, strength, and resistance to heat, chemicals, and abrasion. The several different types of nylon, though related, differ in chemical composition and have different heat resistance, solvent resistance, flexibility, and fluidity at processing temperatures. Typical of this variance are the various Zytel[1] nylon extrusion compositions listed in Table I, p. 719. Other compositions may be used at times, but they are usually similar in characteristics to one of the types which are listed in the table.

The higher-melt-viscosity resins, e.g., Zytel 63 and especially Zytel 42, can be readily handled by the general thermoplastic extrusion techniques. On the other hand, the low-melt-viscosity types, Zytel 101, 31, and 33 have characteristics which require special consideration with regard to extrusion processing.

Extrusion equipment

A typical extruder for nylon resin can be broken down into the following list of important features:

Barrel and heating equipment: Long barrels are desirable for the extrusion of Zytel, because they provide greater heat-transfer area to facilitate melting of the resin. The ratio of the length of the barrel to its diameter should be at least 16:1. A ratio of 18:1 or 20:1 is even better.

Some extrusion operations involving Zytel require temperatures as high as 600° F.; consequently, electric heat is preferred. Oil heat is generally not practical for use in this temperature range.

Normally the hopper section does not require water cooling; however, when necessary to protect the bearings, the minimum amount of water possible should be used.

Hopper feed throat: In order to prevent excessive wedging of resin particles between the flight land and barrel wall, the direct overhead or tangential-type feed throat should be used. The undercut-type feed throat is not recommended.

The screw: A screw of the metering type, with half-turn compression, as shown in Fig. 1, p. 718, is recommended for the extrusion of Zytel. This is a constant-pitch screw, divided functionally into three sections.

The last four flights of the screw comprise the metering section. This section pumps the melt at a uniform rate, and generates sufficient pressure to force it through the die. The channel is shallowest in this section.

The dimensions shown in Fig. 1 are offered as recommendations for typical conditions, and should not be regarded as optimum for all extrusion operations.

Screen and breaker plate: A breaker plate and two 80-mesh screens are normally used to filter out foreign matter.

Extrusion operation

Drying: All Zytel molding powders are hygroscopic; they readily absorb moisture from the air. The exposure of Zytel to the atmosphere for as little as 30 min. can result in the absorption of sufficient moisture to impair the extruded product.

Zytel molding powders, particularly Zytel 42, can be fed directly from the can to the extruder hopper. It is important, however, that contact with the room atmosphere be minimized. The cans should not be opened unless they are to be loaded at once, and the hopper itself should be provided with a tightly fitting cover. It is generally good practice to keep the amount of resin in the hopper below the amount needed for one hour's running. Excessive moisture in granular Zytel is indicated by bubbles or frothing in the extrudate. These symptoms, however, may also be caused by overheating.

For re-work material or unusual extrusion conditions such as elevated temperatures or long hold-up time, it is necessary to dry Zytel prior to extrusion. The drying procedure, which involves an air-circulating oven at 175° F., is described in Du Pont Bulletin X-39.

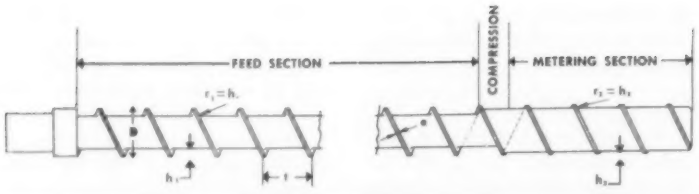
Extruder barrel - temperature profile: The temperature-control point in Zytel extrusion is the melt temperature as indicated by the stock thermocouple (7).[2] This indicated temperature is controlled by regulating the extruder barrel temperatures. In order to minimize temperature spread in the melted plastic, a uniform barrel-temperature profile is maintained. With an 18:1 barrel length and a properly designed screw, the barrel temperature should be only 10 or 15° F. higher than that of the melt. The

* Sales Service Laboratory, Polychemicals Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

[1] Du Pont trademark for nylons.

References were prepared by the editors.

[2] Numbers in parentheses link to References on p. 720.



Suggested dimensions of screw for Zytel 42

Diameter (D), in.	*Pitch (t),* in.	*Depth of feed section (h_1),* in.	*Depth of metering section (h_2),* in.	*Width of land (e),* in.
1½	1½	0.240	0.075	0.150
2	2	0.320	0.085	0.200
2½	2½	0.380	0.095	0.250
3¼	3¼	0.440	0.110	0.325
3½	3½	0.440	0.110	0.350
4½	4½	0.500	0.125	0.450
6	6	0.580	0.145	0.600

Suggested dimensions of screw for Zytel 101, 31, 63, 211

Diameter (D), in.	*Pitch (t),* in.	*Depth of feed section (h_1),* in.	*Depth of metering section (h_2),* in.	*Width of land (e),* in.
1¼	1¼	0.220	0.055	0.125
1½	1½	0.240	0.060	0.150
2	2	0.280	0.070	0.200
2½	2½	0.320	0.80	0.250
3¼	3¼	0.360	0.090	0.325
3½	3½	0.380	0.095	0.350
4½	4½	0.420	0.105	0.450
6	6	0.480	0.120	0.600

Fillet radii at roots of threads (r_1, and r_2) should be equal to thread depths.

Fig. 1: Screw dimensions recommended for different types of nylon

die and adapter temperatures should maintain this controlled temperature. This is done by controlling die temperatures at about 5° F. above the stock temperature.

The foregoing procedure is designed to deliver the extrudate with a narrow temperature distribution which minimizes localized over-heating or cold plugs.

Types of extrusion

Wire coating: As a primary insulation on small wire, Zytel can be applied at very high speeds and in very thin coatings. A rate of over 1600 ft./min. has been achieved with suitable take-off equipment, and a thickness of as little as ½ mil is possible. When nylon is applied as a primary insulation, good adhesion between nylon and wire can be obtained by preheating the wire by flame or electrical heating. Smaller wires can be coated while passing vertically downward into a quench bath. The air gap between the die and the water level of the quench bath should be small—usually ½ in. or less. For larger wire, or where equipment dictates, horizontal operation has been found to be best.

A cross-head and die assembly is generally used for coating wire with nylon. A typical cross-head is shown in Fig. 2, p. 720. Vacuum is applied between the wire and guider tip in order to pull the flowing cone of plastic close to the die. In this way, a smoother coating is achieved, and adhesion is improved. The annular space between the guider tip and the die, at the point where the molten nylon is extruded upon the wire, should have a thickness of between five and eight times the desired thickness of the coating on the wire. The wire passes through the head faster than the molten resin is fed upon it, and the thickness of the layer of resin is thereby reduced as it is deposited on the wire. Thus, the thickness of the coating is controlled by both the output rate of the extruder and the wind-up speed of the wire. Following the quench bath the wire is tested for breaks in the insulation.

The wire coating technique is covered in detail in Du Pont Bulletin WC-2.

Tubing: Tubing is extruded from nylon by the general method employing a cross-head die with an end-supported mandrel which is probably best for tubing extrusion.

In the extrusion operation, air or nitrogen under regulated pressure is supplied through the mandrel as an internal support for the extruded tube. This regulated pressure within the tubing can be varied to produce a variety of diameters and wall thicknesses from a single die. The size of tubing from a given die is governed by extruder output, take-off speed, and internal gas pressure.

Where burst strength is a paramount consideration the die size should be such that the draw-down is 3:1 or less. Draw-down in this case is defined as the ratio of the cross-sectional area of the die opening to the cross-sectional area of the tubing.

Shape extrusion: Zytel 42 is a higher-viscosity 66 nylon resin tailored specifically for extrusion of shapes, tubing, film, and sheet, and for blow molding. The extrusion of shapes from this resin can be accomplished by either horizontal or vertical extrusion into a water-quench bath. The flexible, more complex shapes are generally suited to vertical extrusion, while the heavy, less flexible sections are more readily handled using a horizontal quench bath. The horizontal technique is similar in setup to that typically used for the tubing extrusion.

The variables controlling the shape and size of an extruded

profile are: dimensions of the die orifice, extruder output, extrudate temperature, take-off speed, and air gap (distance between die and quench water).

Film: In the extrusion of film, the machine and die should be preheated to the temperature range recommended for extrusion of the particular composition (Table I, right). After extrusion is begun, the temperatures can be adjusted until desired flow properties are obtained.

The method of handling the film varies with the type of nylon because of variations in fluidity, in strength of the molten film, and in crystallization characteristics.

Zytel 42 is the resin most easily extruded into film. Because of its great melt strength the extrusion can be run with a 2- to 3-in. air gap. This process is illustrated in Fig. 3, p. 720. The extrusion of the more fluid types such as Zytels 31 and 101 is also accomplished in the same manner, but greater precautions are required in the handling of the quench step. The bath must be so arranged that the water level is maintained within about ¼ in. of the die. Since the bath is so close to the die, it is necessary that the former be so constructed and supported that 1) there will be a minimum number of ripples on the surface, and 2) ripples are not reflected by the tank sides.

The flexibility and transparency of nylon film of given thickness are affected by chilling rate. Quenching in cold water tends to make the film more transparent and flexible, while hot water makes it more opaque and stiffer. This sensitivity to temperature of the quench water makes it necessary that the bath have good circulation to prevent the development of localized areas of hot water that will cause streaks and spots on the sheet. At the same time, however, this circulation must not cause impingement of streams of water on the uncooled film.

At this stage, nylon is sufficiently fluid that any strong movement of water will cause unwanted wrinkles to form in the film.

The film is pulled by a pair of driven rubber rolls. The rate at which these rolls are turning with respect to the rate at which the film is being extruded will determine what the final caliper will be. Ratio of the initial cross-section to that of the finished film is called the draw ratio.

Following the pull rolls is an edge slitter. This may be of a razor-blade type, but a shear-type trimmer is preferred. Trimming is necessary to remove the slightly heavier section at the edges. This permits an even wind-up. Winding may be accomplished on either an axial- or a surface-type of wind-up roll.

The more viscous and slower-setting Zytel molding powders such as Zytel 63 and 69, and modifications of these, develop a tacky surface when extruded into a water bath.

The chill roll should be as close to the die as possible. This film must be trimmed, too.

Paper coating: All of the various nylons can be extrusion-laminated onto kraft paper and other substrates, using essentially the

TABLE I: Extrusion of Zytel nylon molding powders

Code	*Extrusion temperatures*	*Remarks*
	°F.	
Zytel 42	500-600	High melt viscosity—for shapes, tubing, and blow molding Most heat-resistant, toughest, and most rigid nylon
Zytel 101	500-600	Low-melt-viscosity resin used for rod and tubing—comparable to Zytel 42 in properties
Zytel 105	500-600	Black composition with excellent weathering characteristics; comparable to Zytel 42 in general properties
Zytel 31	450-500	More flexible, more moisture-resistant than Zytel 42
Zytel 33	450-550	Heat stabilized Zytel 31
Zytel 63	450-550	Extrusion grade of flexible type; flow characteristics comparable to conventional thermoplastics
Zytel 69	450-550	Comparable to Zytel 63, with superior resistance to flexural fatigue
Zytel 211	450-550	Polycaprolactam

TABLE II: Symptoms and possible causes of trouble in extrusion of nylon

Symptoms	*Possible cause*
Bubbles	a) Moisture in resin; drying required b) Temperature too high (Zytel may decompose and discolor) c) Low output—excessive hold-up time in the machine results in decomposition
Bridging—loss in output	a) High rear barrel temperatures b) Improper screw design
Extruder overloading	a) Low extrusion temperature especially at breaker plate b) Improper hopper feed throat design c) Improper screw design

same die recommended for the extrusion of film. With most substrates coated in commercial size equipment, adequate adhesion of the nylon film can be obtained in thicknesses of 1 mil or heavier.

The lamination is accomplished in standard equipment used in extrusion coating of substrates with polyethylene. The resin is extruded through the film die immediately ahead of the nip of the pressure and chill roll. The jaws on the die differ from those used in unsupported film extrusion in that the lips have been extended to reduce the air gap between the die and roll nip to a minimum. The pressure roll is a rubber roll with a Shore Durometer hardness of about 60 that is held against the chill roll mechanically, hydraulically, or pneumatically. For normal coating operations a force of 60 lb. per linear in. of roll length is adequate. The chill roll required has the same design as that used for film. This roll cools the laminate, regulates the thickness of the coating by controlling linear speed of the substrate, and plays a large part in determining the surface character of the finished coating.

It is usually necessary to trim the edges of the laminate to remove the "beading," or thickened edges of resin in order to obtain satisfactory roll-up. These heavy edges are due to the necking-down of the film which occurs as the film is drawn. The trimming operation can be easily performed by means of a rotary-type trimmer. This is a spring-loaded, hardened steel disk.

The uniformity of caliper across the die can be regulated either by making adjustments on the die jaws, or by regulating the temperature in the various zones of the die. A better approach, when possible, is to design the die to produce uniform regulation with so that a minimum of on-stream adjustments will be required.

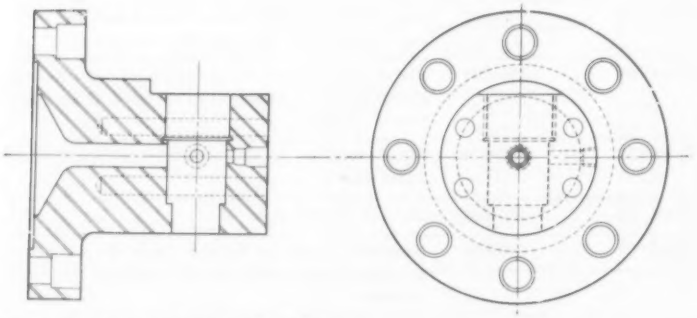


Fig. 2: Cross-head die for extrusion of nylon

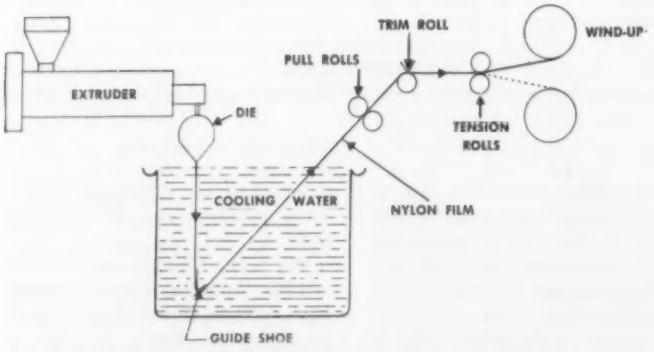


Fig. 3: Assembly for extrusion of film from Zytel 42, 101, and 31 nylons

Cleaning nylon from extruder parts: Nylons are most readily cleaned from extruder parts by burning off the plastic in a "nylon burn-out furnace" (900° F.); where this furnace is not available, the following is done:

After the extruder has been shut down, the screw is removed from the barrel. While the screw is still hot, it is scrubbed with a wire brush and copper mesh. This operation is facilitated if, when shutting down the extruder, the screw is allowed to turn for a short time after the resin supply is cut off. Thus, the screw can force the remaining resin toward the front of the extruder, and thereby purge itself.

With heat still on the barrel, a boiler-tube brush wrapped with copper mesh is pushed in and out of the barrel several times. More copper mesh is then added, and the brush is used again. This procedure is repeated until the barrel shines. A light over the hopper will generally permit good visual inspection of the barrel. The face of the barrel can be cleaned with a wire brush while the machine is still hot. Smaller die parts, bolts, etc., are most easily cleaned by using a hand torch. This operation is followed by wire brushing.

References

For further information on nylon materials, see p. 130; on extrusion equipment, p. 898.

1. "Design and operation of cross-head sheeting dies," Modern Plastics *33*, 127 (Aug. 1956).

2. "Plastic flow paths in an extruder worm," by L. F. Street, Modern Plastics *30*, 130 (Apr. 1953).

3. "Extrusion of nylon," Modern Plastics *30*, 94 (Jan. 1953).

4. "Extrusion of nylon," Modern Plastics *29*, 99 (Aug. 1952).

5. "Progress report on plastic monofilaments," Modern Plastics *27*, 69 (Nov. 1949).

6. "Solids conveying in extruders," by W. H. Darnell and E. A. J. Mol, SPE Journal *12*, 20 (Apr. 1956).

7. "Stock thermocouples, pressure gages, and rupture disks for use on plastics extruders," by E.

C. Bernhardt, SPE Journal (Nov. 1955).

8. "Symposium on the theory of plastics extrusion," by J. F. Carley et al., Ind. Eng. Chem. 45, 969-93 (1953).

9. "Extruded plastic parts," by R. S. Perkins, Product Eng. *23*, 150 (Oct. 1952).

10. "Extrusion of nylon," by C. P. Fortner, Brit. Plastics *21*, 658 (Dec. 1949).

EXTRUSION OF POLYCAPROLACTAM NYLON

BY T. R. VON TOERNE*

Polycaprolactam nylon is a polymer based on the six-carbon-containing molecule, caprolactam, and hence is often referred to as "nylon 6," or "type 6 nylon." It possesses the usual advantages of nylon: high strength, abrasion resistance, light weight, solvent resistance, self-lubrication, and high melting point. In addition, available polycaprolactam nylons offer a number of other advantages in the form of high impact strength, low processing temperature, good dimensional stability, a unique and controllable crystalline structure which can be used to vary the physical properties of extruded parts, and excellent colorability, either during or after extrusion.

The relatively high melt viscosity of certain polycaprolactam nylons facilitates the extrusion of relatively thick films, tapes, small-diameter rods and tubing, and special shapes. In addition, this high viscosity makes these nylons particularly suitable for such applications as the blow molding of bottles.

Extrusion conditions

See Table I, p. 722.

Extruder: Any extruder of sufficient heat capacity to permit continuous operation in the temperature range of 450 to 550° F. is suitable for extruding polycaprolactam nylon. In general, oil-heated extruders are only marginally adequate for even low extrusion rates and an electrically-heated extruder is therefore preferable.

The barrel of the extruder should have at least three heating zones, each equipped with a separate temperature controller, to give the desired temperature profile. The overhead hopper feed throat is preferable. An Xaloy 307 liner is recommended for the barrel.

A metering-type, screw, constant pitch, with either a sharp compression or gradual compression over one to three flights, is recommended for the extrusion of polycaprolactam nylon. Figure 1, p. 723, offers recommended dimensions for this type of screw. Recommended material of construction for the screw is SAE 4140 steel or equivalent, with properly hardened flights.

Temperatures: Polycaprolactam nylon can be extruded over a range of melt temperature between 450 and 550° F., though a range of 450 to 500° F. is recommended for most extrusion work. The machine temperature should be adjusted to obtain the desired melt temperature. A thermocouple for measuring the melt temperature is therefore very desirable in the flow passage of any die head.

If the melt in the extruder is kept hot too long, it degrades and the extrudate suffers from discoloration, brittleness, poor surface, etc. Top safe temperature for 5-min. exposure is 575° F.

Pressures: The proper melting of polycaprolactam nylon requires a sufficient pressure at the discharge end of the screw to insure a uniform homogeneous melt. This pressure depends upon the type of polymer chosen for the application as well as the maximum anticipated throughput requirement. Generally, a pressure of 500 p.s.i. at the lowest throughput will insure satisfactory operation. The building up of this pressure can be accomplished by either: 1) screenpack; 2) die design; or 3) a combination of these two. A pressure gage should be installed at the entrance to the die if possible. Figure 2, p. 723, illustrates one arrangement of a pressure gage in a straight delivery head. The melt thermocouple is also shown.

In cases where no pressure gage is available, a screen pack of 1-20, 1-60, 4-100's, 1-60, 1-20, is adequate for most applications.

Predrying: Most polycaprolactam nylons are supplied in hermetically sealed airtight containers at a moisture content of less than 0.2%, so that normally it is not necessary to dry the material.

Up to approximately ½ hr. (depending on humidity) after opening the shipping container, the molding powder can still be extruded without predrying. For powders that have exceeded this limit, drying times will range from 3 hr. to as much as 16 hr. at 175° F. A vacuum drier or dehumidified oven is preferred to a conventional air-circulating oven for drying nylon. Maximum humidity of air in the dryer should be approximately 60 grains of moisture per lb. of dry air. If a vented extruder is used, it is possible to omit drying if pellets have absorbed only a slight amount of moisture (less than 0.75%). Pellets with more than 0.75% should be dried.

Polycaprolactam nylon scrap can be re-used after drying. The drying time will depend on the amount of moisture absorbed.

Die design

The general principles of good die design that apply to the extrusion of most thermoplastics apply to the extrusion of polycaprolactam nylon. All flow through the die should be streamlined. Areas of stagnation should be avoided since excessive polymer residence time will result in degradation.

Die lands should be long enough to result in a back pressure of at least 500 p.s.i. at the discharge end of the screw. All inner surfaces of the die should be either chrome-plated or of a polished, corrosion-resistant steel.

Figure 2, p. 723, illustrates a typical straight delivery mandrel and die arrangement for extruding tubing.

External setup

Cooling: The rate of cooling of a polycaprolactam nylon extrusion will significantly affect the

* Shadyside Application Research Laboratory, Barrett Div., Allied Chemical & Dye Corp.

TABLE I: Extrusion of polycaprolactam nylon

	Monofil.	*Sheeting*	*Wire coating*	*Shapes*	*Pipe*
A) Machine characteristics					
Diameter, in., of screw needed to deliver at 60 r.p.m.:[1]					
50 lb./hr.	2¼	2¼	2¼	2¼	2¼
150 lb./hr.	3¼	3¼	3¼	3¼	3¼
500 lb./hr.	5¼	5¼	5¼	5¼	5¼
Recommended L/D	20	20	20	20	20
Recommended screw type	Metering, constant pitch, gradual or sharp compression				
Compression ratio[2]	3.5:1	3.5:1	3.5:1	3.5:1	3.5:1
Depth of feed zone in 150 lb./hr. screw, in.	0.100	0.100	0.100	0.100	0.100
Lead ratio[3]	1:1	1:1	1:1	1:1	1:1
Screen pack, mesh numbers in direction of flow	40, 2–100, 40	40, 2–100, 40	40, 2–100, 40	20, 40, 20	20, 40, 20
Drive power for 150 lb./hr., hp.	30	30	30	30	30
B) Operating conditions					
Melt temperature at die, °F.	460	460	485	460	460
Approx. melt pressure at die, p.s.i.	500	500	500	500	500
Screw cooling	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Is feed preheated?	No	No	No	No	No
Entering temperature, °F.	Room temp.	Room temp.	Room temp.	Room temp.	Room temp.
Metal temperatures, °F.					
Rear cylinder	460	460	485	460	460
Halfway along cylinder	475	475	495	475	475
Forward cylinder	475	475	495	475	475
Die	460	460	485	460	460
Is extrudate water quenched?	Yes	Optional	Yes	Yes	Yes
Water temp., °F.[4]	—	—	—	—	—
Air gap, in.	1.0	1.0	1.0	1.0	2.0
Time in water, sec.[5]	0.15 sec. / lb./hr.	—	—	—	—
Draw ratio[6]	1.5–4.0	1.5–4.0	1.5–4.0	1.5–4.0	1.5–4.0

[1] Size to nearest quarter inch. Use next largest standard extruder size when size is not standard.

[2] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[3] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[4] Temp. of water will be determined by properties desired in finished extrusion.

[5] Depends on desired properties, water circulation, dimension of shape. Figure given is approximate.

[6] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

properties of the final part and careful consideration should be given to the method employed.

Essentially, three methods of cooling are used: 1) water bath; 2) air; and 3) contact with cooled surfaces.

Most extrusions can be satisfactorily cooled by tap water. In many cases, however, it is desirable to use a less rapid quench to prevent void formation in heavy sections or to obtain certain desirable properties. All other conditions being equal, quenching in hot water (175° F.) will significantly increase the 1) tensile strength, 2) flexural strength, 3) stiffness, and 4) opacity of the extruded part as compared with a cold-water quench. The more rapid the quench, the more flexible and transparent the part will be.

Postforming: As polycaprolactam nylon is a crystalline material having a sharp melting point, the postforming fixtures must be located so that forming can be done within the first 3 to 6 in. in the cooling bath. Contoured plates, rollers, or guides are required to guide the extrusion and

maintain its desired shape as it is solidifying. This is usually the most important, and frequently the most difficult part of the extrusion operation.

Where water cooling is used, it is necessary to maintain a smooth uniform flow of water at the point where the extrusion enters the water. If this is not done, localized boiling will result which will cause surface imperfections on the extrusion. When cooling extruded tubing, the water level should also be precisely controlled to minimize fluctuations in tubing diameter. This is usually best and most simply done by means of a large adjustable overflow weir at some point along the cooling tank.

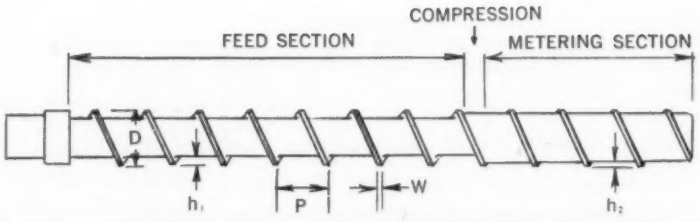
Types of extrusion

Polycaprolactam nylon such as described above can easily be extruded into tubing, pipe, wire covering, rod, tape, film, and special shapes.

The extrusion of tubing can be done either vertically or horizontally, although horizontal extrusion is generally the simplest. A water tank 10 to 20 ft. long, the longer length being required for higher extrusion rates, is used for cooling the tubing. Contoured plates, guides or rollers are needed to guide and shape the tubing as it is being cooled. A set of motor-driven rolls or belts can be used for pulling the tubing from the extruder die through the cooling tank. A coiler is recommended for winding the tubing into coils for ease of handling.

The extrusion of small rod, special shapes, and small tape can be handled much the same as tubing. The guide fixtures should be shaped to help form the particular contour being extruded. Large-diameter pipe extrusion will require either a water-cooled, extended mandrel or a vacuum-type calibrating unit to maintain roundness of the pipe.

Standard wire insulating equipment can be used in covering wire with polycaprolactam nylon. When the latter is used as the primary insulation, it is best to preheat the wire to approximately 325° F. to obtain good adhesion. The preheating can be accomplished with a resistance heater.



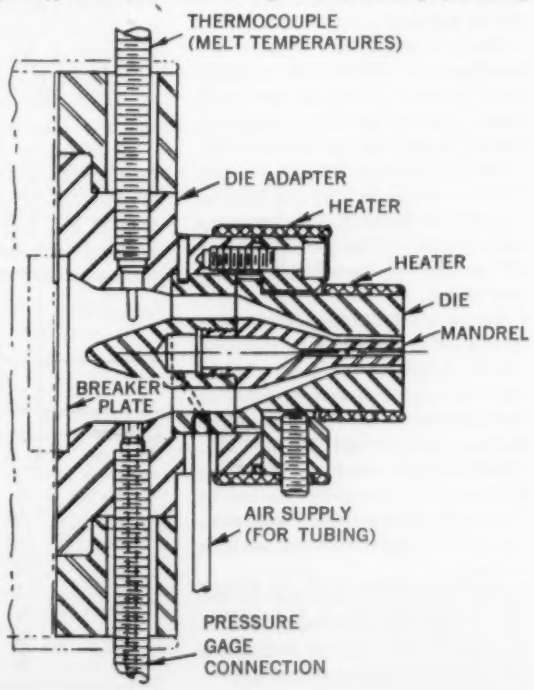
Dia. (D)	Pitch (P)	Depth of feed section (h_1)	Depth of metering section (h_2)	Width of land (w)
in.	in.	in.	in.	in.
1¼	1¼	0.260	0.065	0.125
1½	1½	0.280	0.070	0.150
2	2	0.320	0.080	0.200
2½	2½	0.360	0.090	0.250
3¼	3¼	0.400	0.100	0.325
3½	3½	0.400	0.100	0.350
4½	4½	0.440	0.110	0.450
6	6	0.500	0.125	0.600

Fig. 1: Recommended screw dimensions for extrusion of polycaprolactam nylon

The extrusion of polycaprolactam nylon film can be accomplished by extruding through a slit die into either a water bath or onto a chill roll. The chill roll cooling method produces a clearer and smoother film. Nylon film can also be produced by the conventional blowing method from a tubular die. Standard film haul-off and wind-up equipment with some modification can be used for nylon film extrusion.

In changing material, the following procedure is recommended: 1) Heat machine to 475° F., 2) when nylon drools from die, start screw and starve feed new material into throat, 3) use full feeding when nylon

Fig. 2: Typical die and mandrel arrangement for extruding nylon tubing



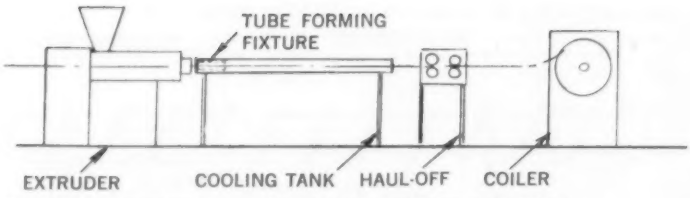


Fig. 3: Set-up for extrusion and take-off of polycaprolactam nylon tubing

emerges from die in steady flow, 4) extruder is ready for running when extrudate is clear.

Maintenance

The cleaning of the extruder can be simply accomplished by shutting off the hopper supply and running the screw until no more material emerges from the die. The head and dies are disassembled and the nylon removed with a stiff wire brush while the parts are still hot. As the hot screw is gradually pushed from the cylinder, the molten material is removed with a wire brush. A wire brush mounted on a drill motor is used to clean the cylinder while it is still hot.

The time for the above procedure can be reduced by purging the machine with a few pounds of polystyrene. The polystyrene is more easily removed from machine parts than the nylon.

A small torch can be used for melting or burning the nylon from the tools and extruder parts in the event the nylon has cooled sufficiently to prevent removal by wire brushing.

EXTRUSION OF TETRAFLUOROETHYLENE

BY WALLACE B. THOMPSON, JR.*, ROBERT E. STABLER*, L. THOMAS BUNN*, and DELBERT N. DeYOUNG*

Tetrafluoroethylene resin (Teflon[1]) offers a unique combination of properties of particular importance to the chemical and electrical industries.

Early in the resin's history, the combination of thermal stability and chemical inertness indicated that Teflon tetrafluoroethylene resins could be used more advantageously than other materials for: 1) making tubing and hose to convey corrosive liquids having a wide range of temperatures and 2) for high-temperature wire insulation.

Initially, limitations were imposed on the production of these forms because the resin could not be melt-fabricated even at temperatures above its crystalline melting point of 620° F. (327° C.). Experimental work in Du Pont laboratories, based on the use of Teflon 6[1] tetrafluoroethylene resin, resulted in the development of a simple and unique technique for overcoming previous limitations.

This technique is based on the blending of an extrusion aid with the tetrafluoroethylene resin and preforming the mixture to a cylindrical billet by compression at 100 to 300 p.s.i. pressure for use in a ram-type extruder. The composition is forced through a forming die by the ram, the extrusion aid is vaporized (at 200 to 575° F.), and the extrudate is sintered and cooled as finished tubing or wire insulation.

Sieving the resin through a 4-mesh screen is recommended prior to blending with the extrusion aid or lubricant. Since excessive working is deleterious to the polymer at this point, the sieve should be vibrated just long enough to allow most of the fine powder to pass through the screen.

Preparation of compound

The addition of extrusion aids to the resin provides compositions which can be extruded at reasonable pressures. The main requirements of a good extrusion aid are: 1) ease of incorporation into the resin and 2) complete and rapid volatilization below the sintering temperature with little or no carbon formation.

VM&P grade naphtha[2] is recommended for general use as an extrusion aid. White oil has also been used extensively for this purpose.

The steps in compounding are as follows:

1) Provide a clean, dry container of suitable size and proportions with a tight closure. For a 1000-g. batch of Teflon, a 1-gal., wide-mouth bottle is a suitable container.

2) Weigh the required quantity of sieved tetrafluoroethylene resin and pour it into the container. Add the weighed quantity of extrusion aid, taking care that the liquid does not wet the walls of the container. The ingredients should be weighed with a precision of at least ±0.5%, preferably ±0.2 percent.

3) As soon as the extrusion aid is absorbed, close the container and shake to minimize adscrip-

[2] VM&P naphtha of specific gravity 0.735 to 0.749; boiling range 194 to 248° F.

TABLE I: Die taper and land length

Cylinder diameter	Tubing size O.D.	Tubing size Wall	Reduction ratio	Die taper	Land length
in.	in.	in.		incl. angle,°	in.
6	4	0.060	35	60	14
6	3	0.060	50	60	12
6	2	0.060	70	60	10
6	1	0.060	135	60	8
6	½	0.045	410	60	6
4	¼	0.030	600	30	4
4	⅛	0.030	1400	30	3

* Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.
[1] See also Thompson, Jr., W. B. and Stabler, R. E., "Paste Extrusion," MODERN PLASTICS 33, 115 (Feb. 1956).
[1] Trademark of E. I. du Pont de Nemours & Co., Inc.
References were prepared by the editors.

tion of the liquid on the container walls.

4) Place the container on a suitable rolling device. (For a 1- or 5-gal. bottle, 20 min. at 15 r.p.m. is recommended.)

5) Seal the container with tape and store the blend for 24 hr. to allow a uniform distribution of the extrusion aid throughout the powder.

The amount of extrusion aid which is required varies with the type of liquid used and the geometry of the extruder. Some experimentation will be required to determine the optimum conditions. Generally, 19 to 25 parts per 100 parts of resin are needed. Adequate precautions should be taken to avoid fire when using naphtha.

Preparation of preform

To prepare the preform, a quantity of the blended composition is compacted in a cylinder which has a core. The dimensions of the cylinder should allow for a 20- to 30-mil radial clearance between the preform and the walls of the extruder cylinder and its mandrel. It should also be at least 2¼ times as long as the preform since the compression ratio of the compounded resin is about 2.25:1.

A weighed quantity of the blended material is poured into the cylinder with care to assure even distribution of the powder around the mandrel.

After inserting the closure plug in the preform cylinder, pressure should be built up to about 100 to 300 p.s.i. on the stock over a period of about 3 minutes. The peak pressure should be maintained for about ½ min. and the pressure slowly released. Great care should be used in pushing the preform out of the die.

Tubing extrusion equipment

The basic equipment (see Fig. 1, above) used for the extrusion of tubing from compounded resin consists of a ram, a mandrel over which the ram travels, a cylinder, and a die, all supported on a frame.

A hydraulic piston is preferred as a device for driving the ram, although a screw-jack has been successfully employed to drive small-diameter rams. Equipment capable of providing 10,000 p.s.i. at the ram face should be adequate for most applications.

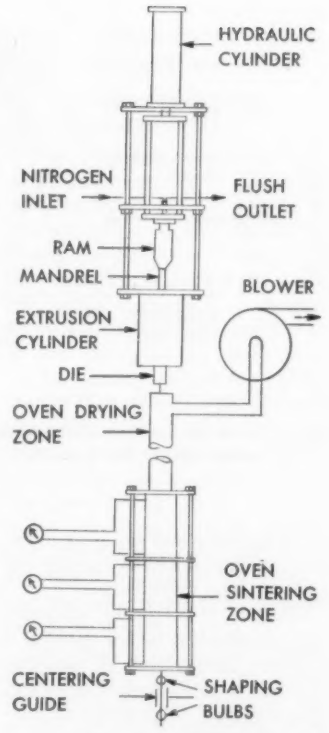
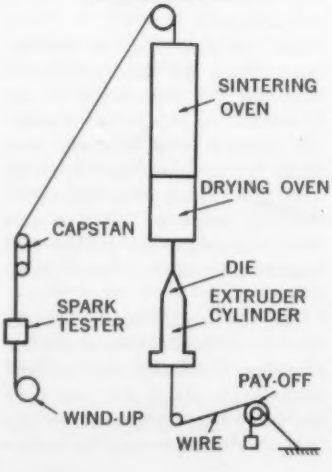


Fig. 1: Basic equipment for extruding thin-wall tubing of Teflon tetrafluoroethylene

For small tubing, the extruder may be either horizontal or vertical, but for tubing more than 1 in. in diameter, it should be vertical. The mandrel forming the bore of the tubing can be straight or tapered at the approach to the die land. The die is normally tapered from the diameter of the cylinder down to the size required for the tubing.

The die land should be long enough to prevent curling or swelling of the extruded piece and to provide enough back-pressure to form a dense product. Table I, p. 724, lists recommendations for land length and die taper angle.

Fig. 2: Basic equipment for extruding wire insulation from tetrafluoroethylene



Tubing extrusion operation

The extrusion process is carried out on a batch basis. The machine must be stopped after each preform has been extruded and a new preform inserted.

In starting up an empty extruder, a tube 2 to 3 in. long, and carefully machined to the proper size, should be inserted in the die land from the discharge end of the die. It should fit snugly since it serves to center the mandrel with respect to the die body. When the stock of resin flows into the annular die land, the stock itself holds the mandrel in a centered position and pushes the positioning tube or centering ring out of the die.

The pressure required for extrusion will vary, depending on machine design and processing conditions. Relatively high pressures are required if the concentration of extrusion aid is low, if the taper angle of the die is relatively large, if the land below the orifice is long, or if the ratio of the cross-section of the preform to that of the product is large.

If the pressure required is too high, the capacity of the machine may be taxed or the tubing may be excessively oriented so that it tends to develop longitudinal splits. If the extrudate is produced under too low an extrusion pressure, it may be weak and porous. This can be corrected by reducing the amount of extrusion aid used or by altering the die and cylinder geometry to increase back pressure.

Drying and sintering of tubing

The tubing is first heated for a sufficient length of time to evaporate the extrusion aid. Initial oven

temperatures, only slightly higher than 200° F., are used for thick cross-sections. Temperatures up to 575° F. can be used for thin walls (such as 15 mils). The tubing temperature should reach 700 to 750° F. in the sintering zone.

Removal of the volatile extrusion aid should be performed at a rate slow enough to prevent blistering. With naphtha as the extrusion aid, less than 5 min. is required for small tubing; up to 20 min. for 2-in. tubing with a 60-mil wall.

The additional heating time required for sintering is approximately the same as that required for volatilization when the heat source is hot air. The use of infrared heat reduces this time.

As much as 40% shrinkage, most of which occurs in the machine direction, may be experienced. Changes in wall thickness perpendicular to the axis of the tubing are very small.

The time the tetrafluoroethylene should remain in the amorphous state at temperatures above 620° F. must be determined experimentally and depends partly on the degree of longitudinal orientation produced during extrusion. The major portion of this orientation must be destroyed so that the finished tubing will have adequate strength in the circumferential direction.

Tubing over about 1 in. in diameter tends to distort out of round during sintering and cooling. This can be minimized by suspending shaping bulbs from the end of the mandrel at a point just below the sintering zone. These bulbs should be smooth, round in cross-section, and ⅛ to 3/16 in. smaller than the inside diameter of the tubing.

For tubing on the order of 1 in. in diameter and larger, nitrogen should be flushed through the tubing via a suction system attached to the hollow mandrel to remove the extrusion aid vapors from the inside of the tubing.

Wire coating extrusion equipment

The equipment used for the extrusion of wire insulation from compounded tetrafluoroethylene resin (see Fig. 2, p. 725) consists of an extruder cylinder and ram, a die, a drying and sintering oven, and standard wire coating pay-off and wind-up machinery.

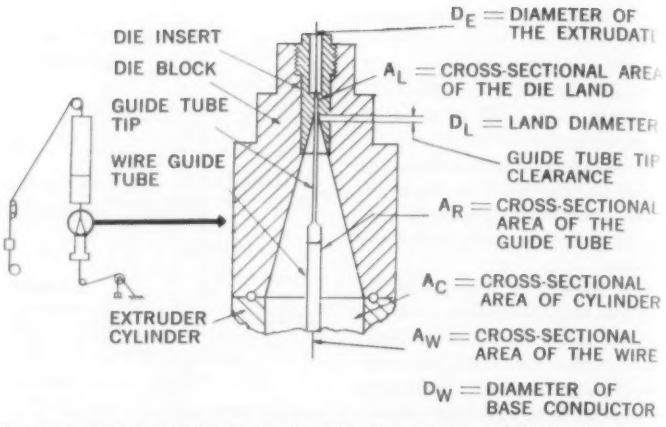


Fig. 3: Die for the extrusion of wire insulation from tetrafluoroethylene resin, used in set-up shown in Fig. 2, p. 725

The ram is driven by a screw-jack mechanism which enables a constant throughput of material regardless of extrusion pressure. This constant throughput of material is required to insure good caliper control of the extrudate. The extruder cylinder and ram should be able to withstand extrusion pressures as high as 30,000 p.s.i.

The die (see Fig. 3, above) is used to form the compounded preform into a strong fibrous coating with the desired wall thickness on the wire. The variables affecting the die performance are as follows:

1) The degree of included angle of the die cone; 2) the diameter of the die land; 3) the length of the die land; and 4) the temperature of the die during the extrusion process.

The included angle of the die cone affects the extrusion pressure and the smoothness of the extrudate. A 20° included angle die appears most suitable, particularly for thin-wall hook-up wire fabrication. Dies having an included angle of 30° are also used successfully for thicker wall insulations such as coaxial cable core.

The die land diameter is the basic determinant of the extrudate diameter. Generally, the die land diameter is about 6% less than the extrudate diameter. The extrudate diameter can be calculated to ± 1 mil by using equation (1) which was derived for the extrusion of Teflon 6 using No. 30 white oil or VM&P naphtha as an extrusion aid. The extrudate diameter is related to the volumetric displacement rate of the ram and the wire coating speed by equation (2).

$$\frac{D_E^2 - D_W^2}{D_p^2 - D_W^2} = 0.944 + 2.85\frac{X}{1-X} \qquad (1)$$

$$V_R = \frac{3\pi}{10^6}(D_E^2 - D_W^2)\,S_W \qquad (2)$$

where: D_E = extrudate diameter in mils; D_p = product diameter in mils; D_W = conductor diameter in mils; X= lubricant concentration in g./g. of lubricated tetrafluoroethylene; V_R = volumetric displacement rate of ram (cu. in./min.); and S_W = wire coating speed in ft./minute.

The length of the die land affects the surface smoothness of the extruded coating. In general, the longer the die land, the smoother the coating. The die land length is limited by shear imposed by the wire which causes the coating to tear when land length is excessive. In practice, die land lengths from ¼ to ½ in. have been found to produce an extrudate having a smooth surface and one that is free from tears.

The temperature of the die during extrusion should be maintained above 75° F. Die heating aids the drying operation by preheating the extrudate, which in-

creases the rate of diffusion of the lubricant to the coating surface where it can be vaporized.

The guide tube and tip provide a guide for the wire through the extruder cylinder to the entrance of the die land. The clearance between the die land entrance and the guide tube tip can be varied to control the length of wire exposed to the compounded polymer in the die.

Wire coating extrusion operation

The wire coating extrusion operation, similar to the tubing operation, is carried out on a batch basis. The preform of compounded tetrafluoroethylene is forced through an extrusion die onto the wire by a ram. The pressure required to extrude this stock is highly dependent on the reduction ratio which is a direct measure of the shear or deformation imposed on the tetrafluoroethylene particles.

In practice, successful fabrication is limited by the upper and lower extremes of reduction ratio. At reduction ratios of 2,000 to 3,000, fracture of the polymer may occur in the die, resulting in an extrudate sheared into discontinuous pieces. At reduction ratios around 100, the particles are not elongated sufficiently to be suitable for wire insulation. These limits also depend on the extrusion aid concentration and the insulation construction in question, and are therefore not specifically definable.

The clearance between the guide tube tip and the entrance to the die land is also an important factor in this process. If the clearance between the tip and the die land is properly set, the average velocity of the lubricated polymer in this area is the same as the wire speed. If the clearance is too large, the polymer speed is slower than the wire speed, which causes excessive shearing of the polymer particles in contact with the wire. This shearing action increases the wire tension enough to cause a wire failure and causes numerous coating flaws. Should the clearance be too small, the guide tube tip tends to plug the die, causing high extrusion pressures. This plugging action causes surging of the lubricated polymer around the wire, resulting in rough, discontinuous coatings.

Drying and sintering of wire insulation

The extrudate of tetrafluoroethylene leaving the extrusion die contains about 19% by weight or 40% by volume of naphtha. In the drying oven this extrusion aid diffuses to the surface of the coating and is vaporized. It is important that all the vaporization of the extrusion aid take place on the coating surface to prevent cracks. The rate of diffusion and vaporization is controlled by the drying oven temperature. Drying oven temperatures generally used are about 300° F. at the entrance up to 575° F. at the exit. During drying operations the oven should be exhausted sufficiently to keep the naphtha fume concentration below 0.9 percent.

The coating leaving the drying oven is very porous. The forces of coalescence in sintering are strong enough to eliminate these voids with a reduction in the coating diameter. The coating must reach a temperature of at least 621° F. for a few seconds to effect this sintering. While the tetrafluoroethylene is in the gel state (621° F.) it should not be submitted to stresses. To enable the coating to be sintered properly, the sintering oven is maintained at 700 to 750° F. The sintering oven should be equipped with an exhaust system to remove possible trace quantities of toxic fumes given off during sintering or from coated wire left inadvertently in the hot ovens.

Adequate ventilation is a recommended precaution against the inhalation of small amounts of gaseous decomposition products encountered when processing Teflon tetrafluoroethylene resins at temperatures above 400° F. (204° C.). The use of proper ventilation is so effective that there are no known cases of ill effects where suitable precaution has been exercised.

References

"Paste extrusion," by W. B. Thompson, Jr. and R. E. Stabler, MODERN PLASTICS *33*, 115 (Feb. 1956).

"Influence of process variables on shrinkage of moldings of Teflon polytetrafluoroethylene resins," by F. M. Chapman and L. T. Bunn, SPE J. *13*, 37 (Feb. 1957).

EXTRUSION OF POLYVINYL CHLORIDE

BY ALLAN G. FOLSOM*

The tabulation of equipment design data for the extrusion of vinyls (See Table I, p. 728, and Table II, p. 729), either plasticized or unplasticized, is not easily accomplished. The complexities of vinyl formulation and the variability in form of the feed material require many mutations in extrusion equipment.

The formulations vary from the hard brittle 98% PVC resin type to a compound having a viscosity little higher than that of a paste. The vinyls are fed to extruders in the form of powder, diced or granulated compound, or in the form of a hot strip continuously supplied by roll mills. In extruding polyvinyl chloride, it should be remembered that no single extruder design can be optimum for all vinyl materials or applications.

Plasticized vinyl

Equipment: Plasticized polyvinyl chloride is successfully extruded on single- or twin-screw extruders. It should be pointed out here that, in normal production, slightly higher physical properties are developed in a compound that is Banbury mixed and milled prior to extrusion. The twin-screw machine is finding increased use in the extrusion of dry-blend material since its high-shearing action compensates for the compound-working lost in by-passing the Banbury mixing and milling operations.

A single-screw machine for the extrusion of dry-blend requires higher heat and frictional input than would be necessary in a machine for extruding diced vinyl

* Development Engineer, Extrusion, Bolta Products, Inc., Div. General Tire & Rubber Co., 70 Garden St., Lawrence, Mass.

References were prepared by the editors.

TABLE I: Extrusion of plasticized vinyls (diced feed)

	Monofil.	*Sheeting*	*Wire coating*	*Shapes*	*Hose*
A.) *Machine characteristics*					
Diameter, in., of screw needed to deliver at 60 r.p.m.:					
50 lb./hr.	2	2	2	2	2
150 lb./hr.	3	3	3	3	3
500 lb./hr.	6	6	6	6	6
Recommended L/D	16:1	16:1	16:1	16:1	16:1
Recommended screw type		Metering	full flight; constant pitch; increasing root diameter		
Compression ratio[1]	2:1	2:1	2:1	2:1	2:1
Depth of feed zone in 150 lb./hr. screw, in.	7/16	7/16	7/16	7/16	7/16
Lead ratio[2]	1:1	1:1	1:1	1:1	1:1
Screen pack, mesh numbers in direction of flow	20, 40, 80	20, 40, 80	—	20, 40, 80	20, 40, 80
Drive power for 150 lb./hr., hp.	25	25	25	25	25
B.) *Operating conditions*					
Melt temperature at die, °F.	300-400	300-400	300-400	300-400	350-390
Approx. melt pressure at die, p.s.i.	1000-3000	1000-3000	1000-3000	1000-3000	1000-3000
Screw cooling	Unnecessary	Unnecessary	Recommended	Unnecessary	Recommended
Medium	—	—	Water	—	Water
Temperature of medium, °F. or wattage in 150 lb./hr. screw	—	—	60-120	—	60-120
Fraction of length heated	—	—	2/3	—	2/3
Feed preheating	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Metal temperatures, °F.					
Rear cylinder	250-350	250-350	—	—	—
Halfway along cylinder	250-375	300-375	—	—	—
Forward cylinder	275-400	350-400	—	—	—
Die	300-400	350-400	—	—	—
Is extrudate water quenched?	Yes	Yes or No	Yes	Yes	Yes
Water temp., °F.	40-80	150	40	40-80	40
Air gap, in.	Min.	Min.	Min.	Min.	Min.
Time in water, sec.	15	30	15	30-300	30-150
Draw ratio[3]	0	0	0	0	0

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

compound. A length-to-diameter ratio of 18 or 20:1 is recommended with a 3.5 to 4.5:1 compression ratio. The flight depth at the head end of the screw and clearance throughout should be much less than those used for diced compounds to insure adequate fusion. A finer screen pack than is used for diced material is generally required for dry-blend extrusion.

Hot-strip feeding is frequently utilized in the production of plasticized vinyl tubing or garden hose. Using a low compression ratio screw at 70 or 80 r.p.m. with strip feed results in a 50 to 100% increase in rate over an extruder fed with diced material.

Monofilament: Plasticized PVC

TABLE II: Extrusion of unplasticized vinyls (diced feed)

	Monofil.	*Sheeting*	*Shapes*	*Hose*
A) Machine characteristics				
Diameter, in., of screw needed to deliver at 60 r.p.m.:				
50 lb./hr.	2½	2½	2½	2½
150 lb./hr.	3½	3½	3½	3½
500 lb./hr.				
Recommended L/D	18:1	18:1	20:1	20:1
Recommended screw type	Constant pitch; increasing root diameter		Constant pitch; increasing root diameter with mixing head	
Compression ratio[1]	2:1	2:1	2:1	2:1
Depth of feed zone in 150 lb./hr. screw, in.	1/2	1/2	1/2	1/2
Lead ratio[2]	1:1	1:1	1:1	1:1
Screen pack, mesh numbers in direction of flow	None	None	None	None
Drive power for 150 lb./hr., hp.	30	30	30	30
B) Operating conditions				
Melt temperature at die, °F.	340-380	340-380	340-380	340-380
Screw cooling	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Feed preheating	Unnecessary	Unnecessary	Unnecessary	Unnecessary
Metal temperatures, °F.				
Rear cylinder	290-310	—	—	—
Half-way along cylinder	320-360	—	—	—
Forward cylinder	360-375	—	—	—
Die	375	—	—	—
Is extrudate water quenched?	Yes	No	Yes	Yes
Water temp., °F.	40-80	—	40-80	40-80
Air gap, in.	4	—	4	Minimum
Time in water, sec.	5	—	60-600	60-600
Draw ratio[3]	0	0	0	0

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

monofilament can be extruded either in the horizontal plane or through a vertical head. The more rigid the compound, the more applicable it is for horizontal extrusion. When extruded horizontally, the strands from the multiple opening die are normally carried to a spreader comb located in the water bath. A softer compound is more readily forced through a 90° head and dropped vertically into the cold water cooling bath.

Film and sheeting: Vinyl film or sheeting can be extruded either through a flat film die or a circular blown-film die. In practice, it is common to use a flat sheet die for materials over 5 mils thick. The fish-tail-type design gives better service with plasticized PVC as it does not contain contours or hot spots common to the manifold-type die. Film less than 5 mils thick is usually produced by extrusion through a circular die to form a thin-wall tube. This tube is inflated with compressed air and allowed to stretch while hot to the desired film thickness. The air-cooled sheet passes through

a set of pinch rolls which maintain the desired amount of air pressure within the tube.

Wire coating: The coating of wire with plasticized PVC is generally accomplished with an adapter known as a cross-head. The operation is somewhat similar to that of making tubes, but in place of a solid mandrel, a hollow cone is used through which passes a heated wire. This hollow cone or guider usually has replaceable tips to accommodate various sizes of wire. The die bushing or orifice is fitted into a die holder which can be adjusted during operation by means of set screws to insure a concentric fitting around the wire. Some designs are so accurately fitted and so well streamlined that they are self-centering.

Die design for PVC

Profile die design for plasticized polyvinyl chloride is dependent on the length of the extrusion run and the complexity of the extruded shape. For the extrusion of complex profiles used in gasketing, it frequently is more profitable to use a rectangular or plate die with minimum streamlining, and clean it often, rather than to produce the costly streamlined die which would reduce down time. For garden hose, however, long runs and simple shape make the use of streamlined tube dies most profitable. A profile plate die for vinyl should have approximately 1 in. of land length for each ¼ in. of cross-sectional thickness. High output of a small cross-section requires a proportional increase in land length. The approach angle for such dies is normally 30 to 45°. Shape and cross-section dimension of dies must be established on a trial-and-error basis but an initial design can be established by allowing for a 20% draw-down on the major dimension and a 5% draw-down in the minor direction. Dies built for long continuous service should always be of stainless steel or chrome-plated.

A tubing die consists of two parts: an adjustable, replaceable outer die bushing, and a fixed but replaceable pin or mandrel. The mandrel controls the inside diameter of the tube and is held in the die by a spider arrangement; the bushing governing the outside diameter of the tube is concentrically adjustable with set screws to insure uniformity of wall thickness.

Purging routine: Removal of the head, lowering of machine temperatures (25°), and the introduction of additional stock result in satisfactory purging. The die must be cleaned out manually.

Unplasticized vinyl

Equipment: As with plasticized vinyl, UPVC is commercially extruded on both twin-screw and single-screw machines. Most commercial extrusion, whether on twin- or single-screw machines, is accomplished by extrusion from granules. Extrusion from preblended powder is an extremely critical process in which the optimum physical properties of the compound may or may not be developed. The double heat history resulting from Banbury mixing and milling prior to extrusion results in high-impact strength in the extruded product.

Much European PVC pipe production is the result of hot strip feeding. In the U.S.A. at the present time, this type of processing has not advanced beyond a speculative interest.

Die design for UPVC

Dies to be used for the extrusion of UPVC should be designed with the utmost possible streamlining. Rectangular or plate dies should not be used. It is preferable that the die be machined from a stainless steel with a high nickel content. Poor machinability, however, makes the use of a 18-8 type more common. An acceptable alternative would be a die machined from SAE 1020 hardened, and plated with chromium to a thickness of 0.0005 inch.

True rigid vinyl materials do not lend themselves to extrusion through offset or cross-head dies. The extrusion of monofilament must therefore be accomplished through use of a horizontal extrusion technique. Rigid PVC film may be extruded using a flat fish-tail design die. Such a film, when oriented biaxially, produces a tough, versatile sheet.

Pipe and tubing is the most common application for UPVC. Available in diameters from ¼ to 12 in., PVC pipe is produced with dimensions similar to those of iron pipe.

Purging routine: Same as for plasticized vinyl.

References

For further information on vinyl materials, see p. 164, on extrusion equipment, p. 898 and other articles in this section.

"1956—the probabilities—vinyl chloride," MODERN PLASTICS *33*, 92 (Jan. 1956).

"What you should know about plasticizers for vinyls (molding and extrusion compounds)," by H. S. Bergen, E. E. Cowell, and W. Waychoff, MODERN PLASTICS *30*, 93 (Nov. 1953).

"Compounding and processing rigid PVC," by R. J. Ettinger, SPE J. *9*, 16 (Feb. 1953).

"Blow extrusion of thin vinyl film," British Plastics *26*, 24 (Jan. 1953).

EXTRUSION OF A-B-S POLYMER BLEND

BY E. J. TRUNK*

Acrylonitrile-butadiene-styrene polymer blend can be easily extruded in conventional equipment. Its relatively high heat stability contributes to this ease of extrusion.

Momentary extruder shutdowns of up to 1½ hr. for minor repairs are possible without lowering cylinder temperatures. Purging of material at the end of a run is unnecessary. The usual procedure for shutdown at the end of a run is to cut off the feed hopper and permit the extruder to run until flow of material from the die stops. Since the screw will clean itself, screw removal is unnecessary.

Material handling

Prior to extrusion, the material must be dried. Drying is most effectively carried out in hopper

* Naugatuck Chemical, Div., United States Rubber Co., 203 Elm St., Naugatuck, Conn.

driers or in open trays with the depth of the granules no greater than 1 inch. Circulating-air or forced-draft systems should be used. Drying time is a function of air temperature and will vary from 4 to 6 hr. at 170° F. to 1 hr. at 220° F. Material may be fed hot to the extruder if a relatively uniform temperature can be maintained. In hopper feed drying systems, it is recommended that the air fed to the hopper should range between temperatures of 180 and 200° F.

Caution must be used to prevent bridging of material because of overheating. The hopper capacity should be 4 to 5 times the extruder hourly extrusion rate. The use of a vented extruder will not completely eliminate the need for material drying.

Equipment

Extruders and screws: Extruder and screws should be of standard material construction as supplied by the manufacturer. The acrylonitrile-butadiene-styrene polymer blend can be extruded with almost any type of extruder screw, but for the most efficient operation, constant flighted screws having a compression ratio of 3 or 4:1 are recommended. Certain blends, e.g., Kralastic B-3 materials[2], require slightly more working, and therefore, are more critical as to choice of screw. Consequently, such screws as the shallow-flighted 4:1 compression, the mixing-type (Dulmage) or the metering-type (nylon) are best for these materials and will give optimum outputs of finished product.

Dies and pins: In general, the straight-through die head is recommended for extrusion of this material. Offset and crosshead dies have been used in the extrusion of pipe; however, with such dies the production of quality pipe is slightly more difficult. Dies and pins should be highly-polished hardened steel and chrome-plated for best performance. The chrome dies generally permit longer extrusion runs between teardowns.

Die land length should be about 16 to 20 times pipe wall thickness. However, a good rule of thumb is to use "square" dies, i.e., land length equal to diameter. The I.D. of the die should be 10 to 15% larger than required pipe O.D. to permit draw-down. This, however, does not always hold when O.D. or I.D. sizing mandrels are utilized. In such cases, die I.D. and finish pipe O.D. remain approximately equal.

[2] Trademark of United States Rubber Co.

TABLE I: Throughputs in various extruders

Screw diameter	*Throughput*
in.	*lb./hr. (ppH)*
1½	35-45
2½	70-100
3½	130-185
4½	175-250

Pin O.D. for use with the 10 to 15% oversize dies is determined by simply subtracting twice the finished pipe wall thickness from the die I.D. For O.D. or I.D. sizing mandrels, the die-pin clearance should be approximately 15 to 25% greater than the pipe wall thickness. Restricted-flow type pins such as are used with the cellulosics also perform well with the acrylonitrile-butadiene-styrene materials.

Screens: In general, screens are not needed to build up back pressure with the material but one or two 20- or 40-mesh screens are recommended to homogenize the material and to prevent cold slugs from passing through the extrusion die.

Pipe sizing: Several methods of pipe sizing are used. Among these, probably the three most popular setups are: 1) first-stage multiple air rings with second-stage water cooling; 2) multiple sizing ring with cascade and/or immersion water cooling; and 3) I.D. water-cooled mandrel with one or two O.D. sizing rings followed by cascade or immersion cooling.

Water bath: The water bath should have a continuous cool water supply and should be 10 to 14 in. wide by 10 to 20 ft. or more long, the length depending on anticipated extrusion rates. The tank should be equipped with adjustable contoured rollers, spaced at 10- to 14-in. intervals to hold the pipe down in the water. On pipe larger than 4 to 5 in. in diameter, it is recommended that water be cascaded over the pipe because of difficulty in keeping larger diameter pipe submerged and the possibility of collapsing the extrusion.

Takeaway or capstan: Unless there is an even, steady pull on the extruded pipe as it leaves the die and is pulled through the sizer, a good product is impossible. For this reason, the takeaway or capstan is probably one of the most important pieces of auxiliary equipment used in the extrusion of pipe.

A capstan, consisting of 4 to 6 drive rollers of contoured rubber, with weighted or spring-loaded idler or driven rollers and a good nonfluctuating adjustable speed drive, is essential. The new rubber timer belt drives are also excellent pulloffs. Drive motors of ½ to 1 hp, or greater are necessary, depending on the size of the pipe.

Operating temperature

Temperature control for acrylonitrile-butadiene-styrene is not quite as critical as for other materials. The appearance and physical properties of the extruded product are the best criteria for determining proper operating conditions. These will vary considerably from one machine to another. Material temperature at the exit of the die is the prime consideration, and this temperature should run from 400 to 440° F. when checked with a needle pyrometer. A typical set of operating conditions would be as follows:

Barrel temperature (feed-end)	350 to 370°
Barrel temperature (center)	370 to 400°
Barrel temperature (die-end)	400 to 425°
Die temperature	400 to 450°

Cooling water is generally not required on the screw.

Production rate

Listed in Table I, above, are the approximate throughputs of Kralastic in various-sized extruders.

Rates for various wall thicknesses on a given size pipe can be easily determined as rates are al-

most a direct function of thickness ratios. However, because of screw reflections or undulated surfaces, which sometimes occur on pipe surface when extruded at maximum rates, a slower production rate is used in order to keep scrap at a minimum.

EXTRUSION OF POLYETHYLENE

Polyethylene can be readily extruded into a wide variety of shapes—pipe, monofilaments, thin films, or other profiles. The material can also be extruded as a coating over wire or onto paper and other substances, where its electrical and mechanical properties are of value. Extrusion conditions for each of these shapes and for coatings vary widely and are summarized in Table I, p. 733.

Extrusion of pipe

Considerable interest and discussion has arisen regarding the various systems for extruding polyethylene pipe. Because of the great diversity of equipment being used in the field for the extrusion of polyethylene pipe and tubing, recommendations must necessarily be general.

Die design: Tubular dies with long parallel lands are generally used for the extrusion of polyethylene pipe. In general, the longer the land, the better the pipe surface, but, in practice, the best arrangement will be dictated by proper balance between factors of compound temperature and production rate. A general working rule for design of dies intended for the extrusion of heavy-wall tubing normally considered as pipe is as follows:

Die size	20% greater than pipe aim OD
Pin size	22% greater than pipe aim OD
Die land	Equal to the die OD

Maximum streamlining in all components is naturally desirable throughout.

Temperature control: In order to extrude polyethylene pipe satisfactorily, good temperature control must be maintained. The temperature of the polyethylene must be sufficiently high as it comes from the extruder to obtain smooth, uniform pipe walls, but not so high as to cause collapse of the extruded section before cooling can take place. This exact point can generally be reached on any given extruder only after a certain number of trials. Compound temperatures below 260° F. should generally be avoided so that good welding or fusing of any pipe seams, produced by the flow of plastic around obstructions in the head or die in the course of extrusion, will be obtained. Compound temperatures which are above 280° F. may make it extremely difficult to produce round, uniform pipe and operations are likely to be hampered by sticking at the sizing plate or by collapse of the pipe as it enters the cooling bath.

Auxiliary equipment: A typical polyethylene pipe extrusion assembly consists of an extruder followed by appropriate pipe sizing facilities, pulling device, and coiling or cut-off equipment. Any mechanical device capable of exerting the required tension on the pipe as it is extruded may be used. Finished pipe should not be deformed or defaced by this.

Pipe sizing: Several pipe sizing techniques have been employed in the field with favorable results. One technique involves drawing the extruded pipe through a cooling sleeve. Another technique employs an internally cooled, tapered mandrel, over which the extruded pipe is drawn to obtain the desired dimensions. A third method involves the use of sizing plates positioned in a water-cooling trough. In this latter technique, by properly adjusting the distance between the two sizing plates used and by employing the correct sizing hole, the diameter of the extruded pipe can be controlled. Final reduction to size will occur through cooling between the second sizing plate and the pulling device. Additional sizing plates can be used where the linear pipe speed is high and longer cooling time is necessary to cool the pipe to the point that shape will be maintained. When using this technique, the I.D. of the pipe can be adjusted to give the desired wall thickness by varying the speed of the pulling device with relation to the rate of extrusion.

Extrusion of monofilaments

Extruder screw: Conventional screw designs have proven satisfactory for polyethylene monofilament extrusion. Screw temperature is a controlling factor in product uniformity and output rate. A bleed of atmospheric steam through the screw or a neutral screw will generally result in the highest output rates.

Die design: The die orifice should be approximately equivalent to the diameter of the monofilament before orienting—never larger in diameter. If the orifices are larger, the monofilaments must be hot-stretched at the die to attain the desired size, in which case they may lack sufficient strength to be cold-stretched in the subsequent orientation operation and frequent breaks may occur.

While the same dies may be used interchangeably for polyethylene and styrene resins, since the recommended stretch for polyethylene (600%) is less than that for the styrene resins (800%), the size of the oriented fibers extruded from the same orifice will be different. Typical die sizes for producing fibers oriented 600% are as follows:

Size of orifice	*Oriented monofilament size*
in.	*in.*
0.070	0.027
0.060	0.023
0.050	0.019
0.040	0.015
0.030	0.012
0.020	0.008

Stretching and orienting: In a typical stretching and annealing process, the polyethylene monofilaments are extruded vertically into a quenching bath of room-temperature water. A travel of 50 to 60 in. is sufficient to achieve cooling. A freely rotating or

Sections on Extrusion of Polyethylene Pipe and Extrusion of Polyethylene Monofilaments prepared from material supplied by Bakelite Co., Div. Union Carbide Corp., New York, N. Y. Table on Extrusion Conditions, p. 733, prepared by Bakelite Co., Div. Union Carbide Corp., New York, N.Y. Sections on Extrusion of Polyethylene Film, Polyethylene Extrusion Coating, and Polyethylene Wire Coating prepared by J. B. Paton, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

TABLE I: Extrusion of polyethylene

	Monofil.	*Sheeting*	*Wire coating*	*Shapes*	*Pipe*	*Film (tubular)*
A) *Machine characteristics*						
Diameter, in., of screw needed to deliver at 60 r.p.m.:						
50 lb./hr.	2½	2	2	2	2	2½
150 lb./hr.	3¼	3¼	3¼	3¼	3¼	3¼
500 lb./hr.	6	6	6	6	6	6
Recommended L/D	20:1	20:1	20:1	20:1	20:1	20:1
Recommended screw type	Metering, decreasing depth					
Compression ratio[1]	4:1	3:1	4:1	3:1	3:1	4:1
Depth of feed zone in 150 lb./hr. screw, in.	0.375	0.375	0.375	0.375	0.375	0.375
Lead ratio[2]	1:0	1:0	1:0	1:0	1:0	1:0
Screen pack, mesh numbers in direction of flow	40/80/50/50/40	20/60/100	20/60/100	20/60/100	20/60/100	20/60/100
Drive power for 150 lb./hr., hp.	20-30	20-30	20-30	20-30	20-30	20-30
B) *Operating conditions*						
Melt temperature at die, °F.	500	380-400	390-450	300	300	300
Approx. melt pressure at die, p.s.i.	1000-3000	500-1500	1500-8000	500-1500	500-1500	2000-6000
Screw cooling	Very slightly to prevent fouling	Yes	Either neutral or cooled screw	Yes	Yes	Yes
Medium	Bleed of atmospheric steam	Steam	Steam	Water	Water	Water
Temperature of medium, °F., or wattage in 150 lb./hr. screw	100-160	230	212	100-125	100-125	120-160
Fraction of length cooled	¼ to total	Total	Total	Total	Total	Total
Feed preheating	Yes	Preferably	Not usually	No	Yes	No
Entering temperature, °F.	190 Max.	190 Max.	190 Max	190 Max.	190 Max.	190 Max.
Metal temperatures, °F.						
Rear cylinder	350	360	350	200	200	200
Halfway along cylinder	464	380	440	250	250	250
Forward cylinder	482	400	440	300	290	300
Die	505	400	440	300	300	300
Is extrudate water quenched?	Yes	No	Yes	Yes & No	Yes	No
Water temp., °F.	100-120	—	60	—	60	—
Air gap, in.	3"	6"	36-120"	—	3"	—
Time in water, sec.	—	—	Less than 2	—	20	—
Draw ratio[3]	4:8	1:10	1:0	1:0	1:10	10:20

[1] Compression ratio = $\frac{\text{Volume of thread in first turn past feed opening}}{\text{Volume of thread in last turn at output end}}$

[2] Lead ratio = $\frac{\text{Distance between corresponding points on successive turns of same flight}}{\text{Inside diameter of barrel}}$

[3] Draw ratio = $\frac{\text{Cross-sectional area of die opening}}{\text{Cross-sectional area of finished (untrimmed) extrudate}}$

driven smooth-face roll at the bottom of the bath will improve the roundness of the fibers. A take-up godet, or driven snubber rolls, may be used to draw the extruded fibers from the die at a uniform rate. It is not necessary to heat these rolls since polyethylene is inherently flexible.

Stretching of the polyethylene monofilament is accomplished by a stretching godet operated at seven times the linear speed of the size control system. Stretching and orientation is carried out in room temperature air. For improved tensile strength, a 575 to 600% stretch is recommended. For maximum tensile strength, the monofilament should be annealed in the water bath under constant tension at 85 to 95° C.

Improved high-temperature shrinkage can be obtained at a sacrifice in tensile strength by passing the monofilament through two annealing water baths at 85 to 95° C. In this procedure, tension should be relaxed approximately 22% in each bath.

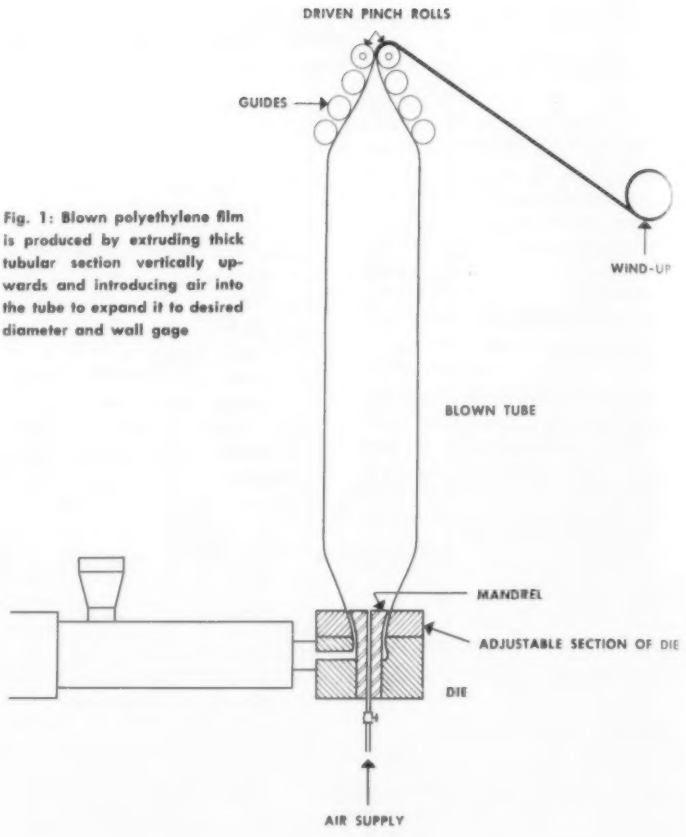


Fig. 1: Blown polyethylene film is produced by extruding thick tubular section vertically upwards and introducing air into the tube to expand it to desired diameter and wall gage

Film extrusion

There are two major polyethylene film extrusion processes for polyethylene resin:

a) Flat film extrusion.

b) Blown film extrusion (expanded tubing).

Flat film: In flat film extrusion, the extruder delivers molten polymer to the die, and from there the film passes into the quench bath, where it is cooled. The cooled sheet passes through a set of pinch rolls, is trimmed, and wound up.

The extruder barrel is heated to between 425 and 500° F., the higher temperature being used for higher extrusion rates.

The die consists of a polished manifold, slotted along its length, and may be equipped to receive molten resin through either of its ends or through an orifice located midway along its length. The manifold should be, where possible, of one-piece construction with a bore that has been precision-drilled, reamed, and given a high polish. The slot should be carefully milled and polished.

The die face can be either 90 or 180°. Flat-surfaced dies which have jaw movement in only one plane can be more easily adjusted by the operator. The die jaw lands, over which the polyethylene resin flows, are about 1/16-in. long and must be carefully polished and maintained. It is desirable to design the die in such a way that die jaws can be adjusted while the machine is running. This may be done with alternate push and pull bolts along the length of the die. The die jaws are set initially to give a uniform opening across the width. This opening for thin film should be between 0.012 and 0.030 inch. If the width of the sheet is to be varied, a short section of 1/8-in. brass rod may be inserted at each end of the die, just above the jaws, in such a way that it can be moved in or out. The rod, forced against the die jaws by the pressure of resins, acts as a check valve.

As the molten film of polyethylene resin leaves the die opening, it is drawn down into a quench tank. The water level may be between 1 and 5 in. below the die face. It is convenient to have the tank height adjustable so that it may be lowered while changing or cleaning dies. The quench water should be fed to the tank with a minimum of turbulence. To minimize surface ripples and maintain a constant level, the water should overflow the sides of the tank through weirs. In order to obtain uniform film properties, it is important that the quench bath be maintained at a constant temperature.

The film, after it leaves the die, is drawn into the quench tank, around a polished roller or stationary guide shoe, and out of the tank by means of a pair of pinch-rolls. The speed of these pinch-rolls governs the draw-down of the molten film as it travels through the air gap between the die and the quench tank, and determines the final caliper of the film.

The trimming operation is per-

formed with either a stationary or a rotary-blade unit. Trimming is necessary to remove the edge material which is thicker than the rest of the film. Usually ¼ to ½ in. is removed from each edge by this operation.

After trimming, the film is drawn through a second pair of pull-off rolls which feed it to the final takeup roll. This roll is usually axially driven and best roll formation has been obtained from a constant torque system of winding.

Blown film: In this method, the stock is extruded from the die as a comparatively thick tubular section which is expanded by air pressure, while still molten, to the desired size and thickness. The tubing is usually extruded vertically upward though it may also be extruded downward or horizontally. Air is maintained in the tube by the closed die at one end and the motor-driven squeeze rolls at the other. From the squeeze rolls it goes to a wind-up machine.

It is of the utmost importance that caliper be uniform to insure wrinkle-free film and even wind-up of rolls. The internal air pressure, extruder output, die adjustment, take-off speed, and temperature are factors which also affect caliper.

In the extruder used for blown tubing, barrel temperatures are lower than those used for flat film extrusion. Temperatures between 300 and 375° F. are typical. The extruder melts and conveys the melted resin to the die.

The die may be bottom or side fed, but in either case the polyethylene flows around a mandrel which forms it into a tube. The die annulus is commonly 0.015 to 0.025 in. and is usually adjusted as soon as possible after start-up.

As the polyethylene tube issues from the die, it is drawn manually to the pinch rolls which take it off at a uniform rate. Air is then admitted slowly through the center of the mandrel to expand the tube to the desired diameter. It is then shut off, leaving a locked volume of air in the tube.

Extrusion coating

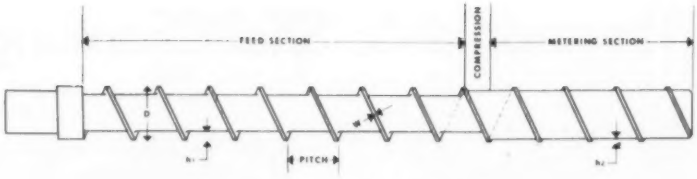
The extrusion coating process consists essentially of these three steps: Film is extruded at high temperature. While in a molten state it is drawn through the nip of two rolls where it comes in contact with the substrata. Pressure is applied by the rolls to effect lamination. One roll is a water-cooled chill roll which solidifies the polyethylene; the other is a rubber pressure roll.

The process requires an electrically-heated machine, since the resin must be heated to a temperature of 600° F. The extruder die should be located so that the film meets the substrata at the nip of the rolls or slightly to the rubber roll side. If it touches the cooled roll first, adhesion will be poor.

The pressure roll is made of a heat-resistant rubber cured to a Durometer hardness of 60. The pressure, though not critical, should be in the range of 60 lb./in. along the surface of contact.

The chill roll consists of a spirally-cored jacket cooled with water so that the surface temperature does not exceed 150° F. The chill roll is driven by a variable-speed motor which draws the film to the desired thickness.

It is necessary to trim the edge of the coated material to remove the bead formed on each edge.



SUGGESTED DIMENSIONS OF SCREW

Diameter (D), inches	Pitch (P), inches	Channel Depth of Feed Section (h_1), inches	Channel Depth of Metering Section (h_2), inches	Land Width (W), inches
1½	1½	0.240	0.075	0.150
2	2	0.320	0.085	0.200
2½	2½	0.380	0.095	0.250
3¼	3¼	0.440	0.110	0.325
3½	3½	0.440	0.110	0.350
4½	4½	0.500	0.125	0.450
6	6	0.580	0.145	0.600

Fig. 2: Metering-type rapid compression screw for extruding polyethylene

Wire coating

Since polyethylene resin is an outstanding dielectric with excellent physical properties, it is used as an insulating jacket in many types of wire construction. In a typical coating operation, wire is paid off from a device which maintains constant tension. Preheating of the wire improves adhesion of the coating and helps to remove any residual oil or drawing die lubricant which may be present. The wire may be heated by either of two methods: by gas burners or by resistance heating.

From the preheater, the wire passes into the die and guider mounted in a cross-head. The pressure exerted by the screw forces the polyethylene resin over the guider and out of the die.

At the same time, wire passes through the guider and emerges coated with a sheath of polyethylene. Wall thicknesses from less than 0.010 in. to greater than 0.500 in. may be applied. The rate at which wire is coated is dependent mainly upon the wall thickness to be applied. Insulations have been extruded on wire at a rate of greater than 2000 ft./min. and on cables about 2 in. in diameter at a rate of 30 ft./minute.

Purging routine

A highly-filled vinyl compound should be used to purge out the polyethylene. Machine should be cooled to approximately 320° F., before purge is begun.

Thermoplastic Sheet Forming

BY ROBERT L. BUTZKO* and E. BOWMAN STRATTON, JR.*

Vacuum forming accounts for the production of the majority of the thousands of jobs now being turned out by sheet forming. In this process, heating and forming take place in one machine, which may be manually or automatically controlled. After the sheet is heated, a vacuum removes the air from between it and a mold, and atmospheric pressure forces the softened sheet against the mold.

The vacuum system of such machines consists of a vacuum pump and reservoir tank. The pumps are of the high-capacity type rather than the high-vacuum type, and deliver a vacuum of about 28 in. of mercury. Both rotary and piston type are used with equal success. In the higher capacities, water-cooled pumps are required. The tanks are of large capacities and, together with the pump, are engineered to provide adequate recovery rate for a particular size of machine. When several machines are installed in one plant, a central vacuum system is usually used, piped to the individual machines. This reduces the cost of the individual machines and saves space.

The development of accurately controllable high-temperature heaters has been a major factor in the rapid growth of vacuum forming. Methods of heating by steam, hot water, hot oil, and infra-red lamps have been used but have been generally discarded since most of these methods of heating are too slow, or result in spotty heating and consequent poor-quality formed pieces.

Present commercial machines employ heaters using electrical resistance wire in some form. Heaters have been made with Nichrome resistance wire encased in fibrous glass tubing and cloth to produce a mat-type heater, which provides uniform heat, but cannot exceed 700 to 800° F. since the glass will crystallize at higher temperatures. These heaters, while satisfactory in the past, cannot compete in the high production requirements of the present day; because of the comparatively low temperatures available, heating cycles are too slow. For example, 0.100-in. thick high-impact styrene sheet requires over 100 sec. to heat using a mat-type heater; present-day heaters will accomplish the same result in approximately 40 seconds.

Many new machines employ heaters using enclosed tubular-type elements. These completely sealed units have exceedingly long life since the elements are not exposed to humidity, dust, mechanical abrasion, or fumes from the plastics sheets being heated. The design of the heater is not uniform, but is worked out to compensate for heater travel, cold-air flow, and edge-cooling effect. Heaters are constructed with stainless steel throughout for resistance to corrosion, and are heavily insulated to prevent heat loss to the working area. Insulation below the heater in the nonheating cycle makes the machines comfortable to operate and, at the same time reduces the electrical drain.

The application of controls to the basic machines results in an approach to automation. In general-purpose machines, the variables of heating, cooling, and forming require constant control and the design of the control system is of the sequence type.

In general, compressed air is used to motivate most of the actions in this type of equipment. This is practical because air devices provide the long stroke and variable speeds necessary for this process. Most modern machines provide both automatic and manual controls. The setup and determination of the factors of forming are tested manually. Then, after the process has been smoothed out, the machines are switched to automatic control and production begins without further manual operation.

While it has been stressed in many articles on sheet forming that pressures in vacuum forming are relatively low (14 p.s.i. or less), it must not be overlooked that the *total* pressure exerted on a large mold can run to high values. Thus, for example, when using a mold 48 by 72 in., a pressure of 48,000 lb. is imposed on the sheet and also on the table to which the mold is gasketed. As the vacuum is pulled, atmospheric pressure tends to force the sheet downward against the mold and also, in effect, to force the table upward. Machine tables must be adequately heavy and strong to withstand this sudden impact; other structural parts of the machines must be strong in proportion. Present-day vacuum forming machines are of all-steel construction and embody the latest in welded and machined structural elements.

The following discussion treats with machines that form by straight vacuum or drape or a combination thereof or which are based on some variation of pressure or mechanical forming. There have been some recent developments in the field. Two new techniques have aroused interest —plug-assist forming, in which a plug, which approximates the shape of the cavity, forces the sheet down into the mold, and air-slip forming, in which the male mold is carried upwards toward the clamped sheet compressing the air between the top of the mold and the sheet. Toward the end of the stroke, the male mold catches up with the bubble thus formed, the trapped air is evacuated, and the sheet is pulled down against the mold. Another type of machine under development is the "rotary" type which is based on the idea of a large turn-table

* Auto-Vac Co., 1984 State St. Ext., Bridgeport, Conn.

References were prepared by the editors.

revolving in front of the operator. Stopping at each 120 degrees of travel places the clamping frame in front of the operator who can then unload and reload.

Straight vacuum machines: One of the easiest types of forming at the present time is the use of vacuum alone to pull a heated sheet into or over a mold. This type of forming may be performed on a special machine for straight vacuum only, or may be performed on one of the combination drape and straight vacuum machines that are on the market.

In a straight vacuum machine, the sheet clamp is usually attached to the mold or mold box, and is operated manually. In the combination machines, clamping is automatic. In the latter, the operator places the plastic sheet atop the mold and presses the starting buttons. The machine takes over, clamping the sheet, sending the heater over the sheet, heating for a timed interval, and opening the vacuum valve. After a timed cooling period, the vacuum is shut off, the clamp opens, and the formed piece is removed. The operator then inserts another sheet for the next cycle. With this type of operation, one operator may run two machines or may do other work such as trimming the formed parts. With the heater directly over the sheet and mold, split-second control of the heating cycle allows the vacuum valve to snap open when the exact molding temperature is reached.

Products made by this process are of the low-profile type, since the deeper the cavity, the thinner will be the plastic form. A rule of thumb generally used is that straight vacuum is used where the diameter of any opening is no less than twice the depth.

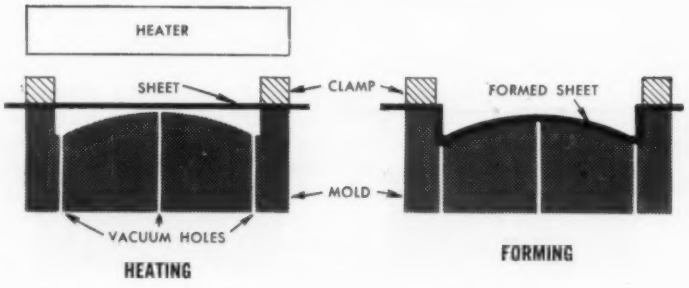
Vacuum forming plastic sheets decorated by silk screening or printing has developed into big business. By coloring flat sheets in a distorted pattern which is registered in the clamping frame, pieces with highly accurate decorations may be produced inexpensively. Rigid vinyl is used for most of these products although styrene, acetate, butyrate, and acrylic are also used.

Straight vacuum forming over male mold: A variation of straight vacuum forming is vacuum forming on a male form placed in a cavity. This type of forming places the thickest part of the plastic part on the top, resulting in a stronger part. However, much more waste occurs since the plastic must be drawn down the sides of the female portion sufficiently far to prevent excess thinning at the base of the male plug. This type of forming was used extensively before the development of equipment for drape forming, described below. Some products with low profiles are still molded economically by means of this method.

In the molding of one type of three-dimensional map by this process, vacuum is applied to the combination mold before heat is applied to the sheet. As the sheet softens, the vacuum drapes the sheet over the male mold and down around the sides. When the sheet is fully formed, the heat is removed. Proponents of this type of molding claim that greater accuracy of registration is possible since the sheet is immediately locked on the projections of the male mold.

Drape forming over male mold: By the drape process, plastic products can be formed with

VACUUM FORMING OVER MALE MOLD



DRAPE FORMING

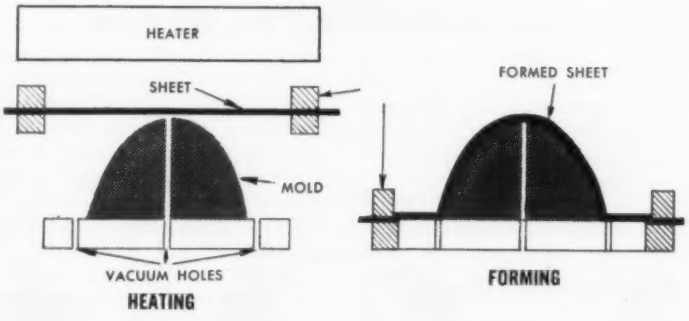
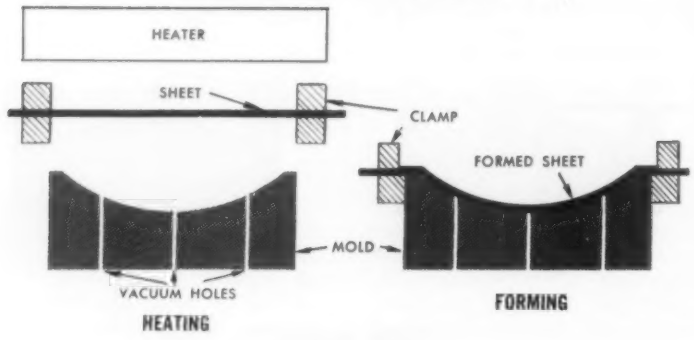


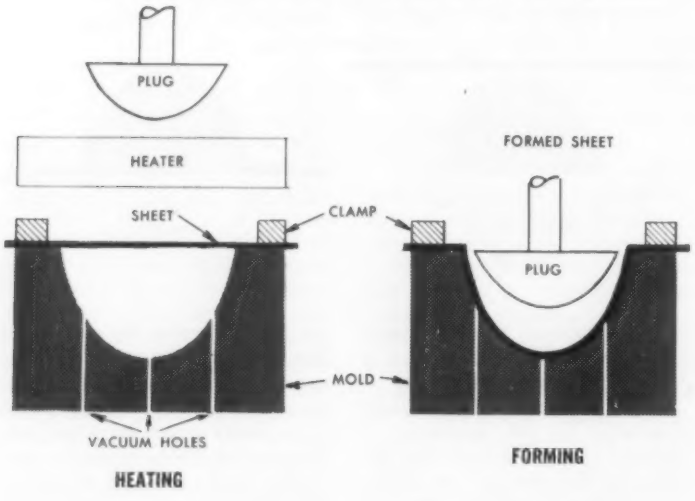
TABLE I: Heat cycle and forming temperatures

Material	*Gage*	*Heater temperature*	*Distance between heater and plastic*	*Temperature cycle of plastic sheet*	
	in.	*°F.*	*in.*	*sec.*	*°F.*
Polyethylene	0.020	1200	7	20	350
Styrene copolymers	0.020	1200	7	7	315
Cellulose acetate	0.020	1200	7	8	325
Flexible vinyl copolymers	0.020	1200	7	14	320
Rigid vinyl copolymers	0.020	1200	7	6	280
Butyrate	0.020	1200	7	9	320

DRAPE FORMING INTO FEMALE MOLD



VACUUM FORMING INTO FEMALE MOLD WITH HELPER



thick wall sections without extreme waste. In low-profile forms, parts may be formed either by straight vacuum or by the drape process; however, a better product can be formed from a thinner sheet by the drape process. In the drape process the plastic sheet is draped or pulled over the male form until the level of the sheet is down to the lowest height of the mold. The sheet is then sealed at the edges of the mold and the vacuum applied, pulling the sheet to the contours of the mold. Parts may have female sections within the male form, thus making possible the successful forming of many complicated shapes.

Forming of precolored sheets can be accomplished, but very close control of prestretching is required. The use of temperature-controlled molds eases this process since the slip of the plastic sheet is governed by mold temperature.

Refrigerator parts are among the high-production items formed by the drape process. The inner side of a door is a prime example. Formerly these doors were injection molded, usually on 200- or 300-oz. injection machines. Mold cost ran approximately $25,000 each and required from 14 to 20 weeks to obtain. Vacuum molds cost from $1200 to $2000 each and cutting dies from $2000 to $4000. These molds and dies may be obtained in about 6 weeks. With such low tooling costs, vacuum forming permits design changes to be made every year, whereas most injection molds are expected to last three years to amortize the tooling.

Drawing to extreme depths is a recent development of the drape process. Rigid vinyl is us successfully to form parts which the depth is 1½ times th diameter, but normal draws the drape process seldom exce a 1 to 1 ratio of depth to diamete

Drape molding into femal cavity: A variation of the drap process is draping into a femal cavity. Some materials such a flexible vinyl or some of the heavy plastics will droop consid erably upon heating and lock upon the mold, causing uneven products. By elevating the sheet in the heating process, the plastic is held far enough away from the mold so that the plastic sheet will not touch it. After heating, the sheet is draped in the conventional manner and the vacuum forms the part.

Automatic roll - feed drape forming: On one machine, the operation is completely automatic, requiring no operator in constant attendance. As many as 50,000 small parts per hr. are possible and such jobs can run 24 hr. per day without interruption. Unlike hand-fed operations in which slight variations of cycle require slight adjustments during the day, the completely automatic vacuum forming machine will run continuously without cycle variation.

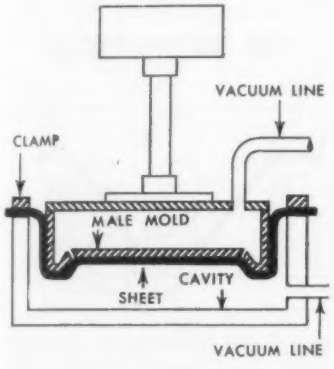
Temperature-controlled molds are a must. They are heated to the required temperature before the first cycle. Any material now on the market may be used in any thickness which can be rolled without a permanent set. The usual thicknesses are from 0.005 to 0.040 inch. The average roll from 12 to 15 in. in diameter weighs from 100 to 150 pounds. With this equipment, the material, on a roll at one side of the machine, is drawn over the mold where the clamping, heat, drape, and vacuum are applied automatically. At the end of the cooling cycle, the material is automatically unclamped and indexed forward.

An average thin-walled package part may be run 3 cycles per min. in a multi-cavity mold. Since the finished parts are still in web form as they leave the machine, they may be fed directly into an automatic cutter or directly into loading equipment.

Forming into a female mold

With helper: In order to reduce the thinning at the bottom of a part drawn into a female mold, a male plug may be used. In this case, after the plastic sheet is heated in place over the female mold, the plug is pushed downward against the sheet, drawing material from the sides into the bottom of the mold. Then, when the vacuum is applied, the bottom of the sheet has only a short distance to travel and does not thin out as much as with straight vacuum. This process has a disadvantage in that the plug will leave a mark-off on the sheet. The design of the plug is very important since just the right amount of plastic must be forced down to prevent thin spots from showing up in the side walls of the formed part.

VACUUM SNAP-BACK FORMING



Extrusion vacuum forming: One of the most economical processes is vacuum forming the hot plastic sheet as it emerges from the rolls or die of a sheet-extruder setup. Proponents of this type of forming emphasize that all scrap can be reground and fed back into the hopper of the extrusion machine. Utilizing the heat already in the sheet, the forming in some cases is done directly as the sheet is extruded. In other cases it is necessary to have additional heat, since the sheet cools rapidly as it leaves the extruder.

In one type of forming, the sheet emerges on a moving belt and the mold is manually dropped on it and travels with the sheet and belt. After the mold has made contact with the sheet, the vacuum is turned on and draws the plastic into the mold. After the mold has traveled with the sheet until the part is cooled sufficiently, the vacuum is turned off and the mold lifted off and reset on the next section of the plastic sheet.

In a later type of machine, the mold is lifted and indexed automatically. In most extrusion-vacuum forming operations the molds are applied to the top of the sheet.

Snap-back forming: Another variation of vacuum forming is snap-back forming in which the sheet plastic is clamped on top of a vacuum box and heated. When the sheet has reached the correct temperature, vacuum is applied to the vacuum box, the sheet is pulled down to a predetermined depth, and a male plug, lowered into the cavity, clamps air tight on the vacuum box. The vacuum is now released from the box, and vacuum is applied to the male plug. The vacuum pulling through the tiny holes in the plug snaps the sheet against the plug, forming it to the contours of the plug.

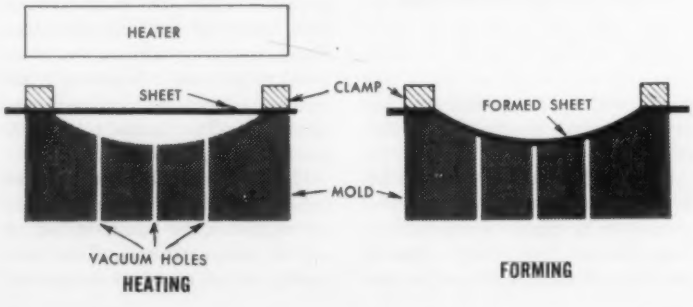
Some fabricators use vacuum in the box only. In this case, when the vacuum is released slowly, the natural tendency of most thermoplastics to return to their original flat shape causes the sheet to settle back against the plug. In this type of forming, however, reverse projections cannot be formed, but very little mark-off occurs and optical clarity of the material can be maintained. Snap-back forming is performed in an air press with an overhead piston and, as a general rule, the plastic is clamped in a frame and heated outside the press.

Free vacuum forming: For some types of forming where perfect optical clarity must be maintained, the plastic sheets can be molded into spherical shapes by free vacuum forming. Skylights, for example, are molded in this manner. The plastic sheet is clamped over a vacuum box and heated. When the sheet reaches the proper temperature, vacuum is applied, drawing the sheet into the box. When the part is of correct depth, the vacuum is reduced and held until the part cools. An electric eye circuit, actuated by the formed part when it reaches a predetermined depth, may be incorporated in the setup to control the vacuum.

Pressure forming

Since vacuum provides only about 14 p.s.i. pressure, better results may be obtained on some plastics and some products by using air pressure. Pressure up to 150 p.s.i. has been used. The equipment required is much heavier and consequently more expensive. Hydraulic presses with high ram speed and pressures from 50 to 200 tons are used and usually high-capacity hydraulic pumps are necessary. Most of the early flexible vinyl place mats were formed this way. Although production is usually slower than vacuum forming, better detail results from the higher pressure. Unlike vacuum forming, only metal molds may be used since the pressures will break down other materials. Care must be taken in making the molds since the pressure will force material

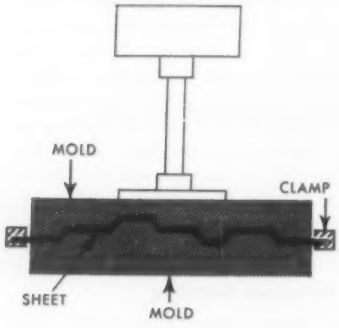
VACUUM FORMING INTO FEMALE MOLD



into any undercut and lock it in the mold.

Heating is accomplished by clamping the material in a frame and placing it in an oven. After heating to the proper temperature, the frame is placed in the hydraulic press and clamped shut. Air pressure then forms the

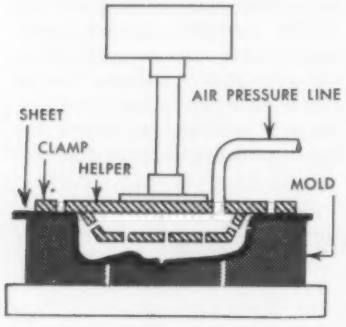
PRESSURE FORMING



part. Thinning is quite similar to that encountered in vacuum forming.

Pressure forming into female mold: In this type of forming, a hydraulic press is used to clamp the mold with the pressure plate and clamping must be adequate to resist the impact of the pressure. The metal female mold is

FORMING INTO FEMALE WITH HELPER AND AIR PRESSURE



clamped to the press base and the pressure plate to the top of the press.

The plastic sheet is clamped in a frame and heated in an external heater to proper temperature. The clamp frame and plastic sheet are then transferred to the press and the press closed. Air pressure applied through holes in the pressure plate forces the plastic to the contours of the mold. Molds must be carefully polished since the pressure will pick up any defect in the mold and result in an unsatisfactory product.

Pressure forming into female mold with helper: To reduce the thinning that occurs in a female mold, a helper plug is sometimes mounted on the pressure plate. This has the effect of prestretching the plastic and drawing material from the side walls into the bottom of the cavity. The forming process is identical to that outlined for pressure forming into a female cavity. The design of the plug is important to pull the correct amount of plastic from the side walls.

Free blowing: Products requiring high optical clarity, such as aircraft canopies, may be formed by free blowing. In this type of forming, the plastic sheet is held in a clamp whose inside contour is the outline of the base of the finished product. The plastic sheet is heated and clamped over the top of a pressure box. Air pressure is then applied, blowing the plastic sheet to the required shape.

Many special jigs and adapters are necessary in this process to produce complicated shapes. Most of the success of this type of forming is due to the individual skill and techniques of the operator.

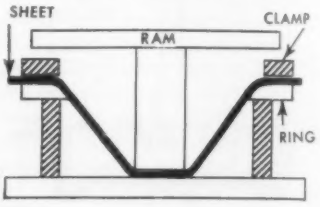
Mechanical forming

The oldest method of forming is by the use of straight mechanical actions without vacuum or air, and has many variations. Essentially, any sheet of correctly heated thermoplastic may be formed mechanically. Usually heavy mark-off occurs so the products must be those where this factor is not objectionable. Sheet metal equipment such as crank presses, benders, air presses, rollers, and creasers are used, as well as special tools such as curling equipment.

Male and female dies: Forming by male and female molds is accomplished by using molds of almost any material. The best molds are of matched metal but these are also the most expensive. In this process, the sheet plastic is heated in an oven or on a hot plate. When at the proper temperature, the sheet is placed over the female mold mounted in an air press. The male part of the die, which is attached to the ram of the press, is lowered, shaping the plastic between the two halves of the die. After a cooling period, the part is removed.

Plug and ring: A variation of male and female forming is the plug and ring, which has several different approaches. In this case, the plug and ring do not resemble the final part but the shape is drawn between the two. The plastic sheet, heated conventionally, is clamped over the ring and

PLUG AND RING FORMING



the plug is forced down into the sheet for a predetermined distance, forming the part.

Another method is to have a ring and a plug of smaller diameter, leaving just enough room for the plastic. The forming operation will produce a cup or shape with straight side walls.

A third variation, applied successfully for forming thin plastics sheets to shallow depths, uses a cold sheet. The male plug is heated and used on a slow-acting air or hydraulic press. The heat of the plug causes the plastic to stretch and form between the ring and plug.

Slip ring forming: In the previously described mechanical processes, the deeper parts stretch out considerably, resulting in thin side walls. In order to make a stronger part, a plug and ring setup may be used, in which the clamp exerts only low pressure. After heating conventionally, the plastic is held in this clamp and the plug pushed into the plastic

to draw the part. The loosely-held plastic sheet will slip under the clamp and draw into the side walls, producing a part with thicker walls than would be otherwise possible. Various types of clamping methods have been devised to control this slippage and to prevent the clamp from chilling the sheet.

In a variation of this type of forming, a grease-covered mold is used. The mold and plug must be heated so that the grease film is actually liquid. This reduces the mark-off which occurs from the slipping of the plastic.

Forming and bending: A considerable amount of straight forming and bending is performed in the course of fabricating sheet plastics. For example, in fabricating tubes for packages, the ends of the tube are spun over or beaded against a heated spinning die. The curve of the die rolls the end of the tube over into a perfect bead.

To bend angles in sheets, localized heating is used. The sheet is suspended over a tubular heating element and heated in the area to be bent. The part is then formed in a hinged blender or a sheet-metal brake.

The necessity for forming a part on one machine and trimming it on another has in some instances discouraged the use of sheet forming. Recently a vacuum, drape, and plug forming machine that also trims the product has been developed. The trim is reground and re-extruded, usually along with virgin material.

Special considerations

The most important factor in vacuum forming is the heating cycle and the control of the heater. Heat uniformity is extremely necessary. Rapid heating is also required, not only to provide production speed, but also to obtain maximum results. Experience has shown that a superior product will result if a sheet can be formed with a short heat cycle and a high-temperature heater setting.

The forming characteristics of the presently-available plastics sheet materials are many and varied. It would be virtually impossible to catalog them precisely. However, the following paragraphs summarize the salient points of forming techniques, as applied to various sheet materials, which have been established as a result of practical experience.

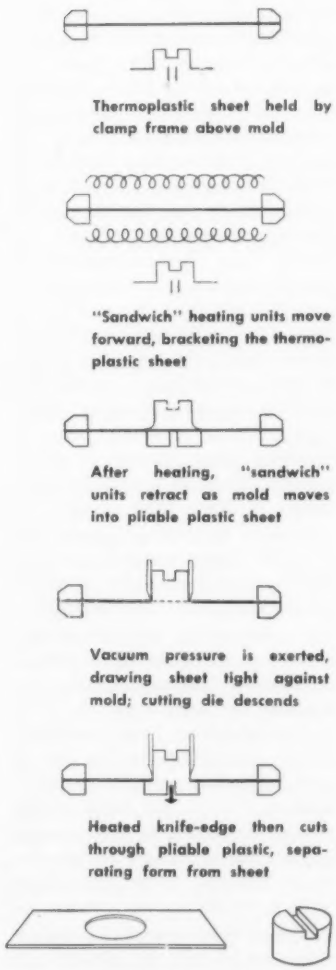
Polyethylene is formable between 350 and 375° F. It is slow to heat and equally slow to cool. The heat cycle must be precise for optimum results. Draping action is preferably very slow, and control of the mold temperature as well as the temperature of the clamping frame must be held closely to 130° F. Unless the parts are cooled below 125° F. before they are removed from the mold, considerable warpage will occur. Properly handled, polyethylene can be formed into a wider range of female molds than any other material, i.e., in some instances, polyethylene can be formed into a 90° angle without thinning the material excessively. It is possible to deep-draw polyethylene on male forms; however, considerable care must be taken with drape-assist frames to avoid webbing at corners and between high points.

Styrene copolymers are very flexible in their forming characteristics. Apparently good results can be obtained over a relatively wide temperature range. This characteristic, however, is deceptive since it can be shown on specific tests that a superior product will always be obtained if the heating cycle varies no more than 2 sec. from the optimum. In other words, too little or too much heat will cause high strain and brittleness. In deep-drawing, considerable care must be taken to overcome chill marks or "ridging." This phenomenon, which occurs to some extent in all materials, is very apparent in the styrene copolymers, and is caused by the fact that the area of the sheet that first lands on the top of the plug chills too rapidly; as the sheet is further draped, the cooled portion pulls over the top of the plug, resulting in a ridged effect. Some of the newer formulations show an improvement in this characteristic. The solutions of the problem will vary with each application. In general, the die must be well-heated and the drape stroke must be adjusted very closely.

Until recently, these materials had not been used widely in preprinted applications. It was found that the latent extrusion strains of the sheet varied too widely from sheet to sheet and from batch to batch. Improved extrusion methods have made it possible to control the strains.

Cellulose acetate forms in the temperature range of 300 to 325° F. The critical forming problems with acetate are the elimination of blushing or fogging at points of high strain and the maintenance of clarity close to that of

FORMING AND TRIMMING IN ONE OPERATION



Thermoplastic sheet held by clamp frame above mold

"Sandwich" heating units move forward, bracketing the thermoplastic sheet

After heating, "sandwich" units retract as mold moves into pliable plastic sheet

Vacuum pressure is exerted, drawing sheet tight against mold; cutting die descends

Heated knife-edge then cuts through pliable plastic, separating form from sheet

Trimmed end product is removed from sheet. (Sketches, Vacuum Forming Corp.)

the original sheet. Blushing can be overcome with adequate heat both in the sheet and in the mold.

Cellulose acetate can be successfully formed on molds maintained at a much higher temperature than most other materials. Loss of clarity, irrespective of mold surface, is caused by overheating and burning, which is evidenced by the formation of small bubbles within the sheet. Practice shows that all acetate sheets react best if heated as quickly as possible. Better results can be obtained if acetate is heated in 7 sec. with a 1200° F. heater than in 20 sec. with a 700° F. heater. Thin-gage acetate between 0.005 and 0.010 in. is highly susceptible to webbing between multiple dies and on all sharp corners. There is a definite limitation of draw with these materials in the vertical wall and in depth. Drape-assist frames are necessary and must be carefully handled to achieve best results.

Flexible vinyl copolymers are highly critical forming materials when deep-embossed detail is required. The heat cycle must be controlled with a 1-sec. variation. Molds should be run as hot as possible and no mold temperature control is required. Care should always be taken to use vacuum holes with diameters no greater than 0.012 to 0.015 inch. Care should be taken that there are sufficient holes to assure complete drainage of the die detail and, most important, that rapid air evacuation is provided. Very little successful work has been accomplished in draping the flexible vinyls over deep, straight-wall plugs. The material will not hold together on deep-drawing and will develop webbing which is practically uncontrollable. Preprinting on these materials requires careful control and great patience. Excellent results are being obtained in such end products as wallets, place mats, and colorful Halloween masks.

Rigid vinyl copolymers are easier to form in a much wider range of applications. They are among the few materials which can be successfully drawn over a round plug 12 in. across and 12 in. deep, with a vertical side wall. Close mold temperature control is important since good results require that the mold be no hotter than 120° F.

Although these materials are used in 90% of the preprinted applications today, complete control must be maintained of all forming operations throughout production in order to obtain consistent results. Two seconds variation in heating time is sufficient to throw the printing completely out of register. Care should be taken that the clamping frame be adequately warmed prior to forming so that the heat loss at the edge of the sheet from a cool frame will not affect the printing.

Cellulose acetate butyrate is one of the least critical of the forming materials. Webbing occurs rarely except in the very thin gages and on plugs with deep square corners. Molds should be run between 150 and 160° F. since with both acetate and butyrate, once the shape has been formed, a setting or so-called chilling effect occurs; unlike vinyl and styrene copolymers, acetate and butyrate can be handled with less cooling without losing shape. One problem with butyrate is to prevent overheating which will immediately become evident by a light surface bubbling; larger internal bubbles will develop if the overheating continues. The problem and solution for maintenance of clarity with butyrate is the same as with acetate.

Cast acrylic is a difficult material to form, particularly in gages over 0.063 inch. Simple hemispheres and shallow forms present no problem except to maintain freedom from mold mark-off. To deep-draw the thicker gages of cast acrylic sheet by the drape and vacuum process, it is necessary to overheat the material with consequent loss of clarity, and in many instances even an overheated cast acrylic will not conform to sharp detail with light atmospheric pressures.

Extruded acrylic and straight polystyrene can be formed with less difficulty. Due to the relatively high strains in these materials, considerable care should be taken to avoid warping of the formed piece. To maintain highly polished surfaces, it is important to use highly polished molds and to keep the molds fairly hot during production.

Two-way oriented styrene sheet requires a great deal of control, particularly in the heat cycle. These are often called the split-second materials since heat cycles must usually be controlled within one second. The use of drape forming with these materials is highly questionable and even in forming into female molds only shallow forms and wide radii should be attempted. It is important to run the molds with these materials at a very high temperature.

References

For specific information on materials for forming, see the Subject Index. For suppliers, see the Directory Index, p. 1018.

"Progress report on sheet thermoforming," MODERN PLASTICS *34*, 107 (May 1957).

"Thermoformed scenery for TV," MODERN PLASTICS *34*, 100 (April 1957).

"Automatic sheet forming," MODERN PLASTICS *33*, 119 (Aug. 1956).

"Trapped-sheet forming," by E. T. Aldington, P. S. Rath, and A. M. Tobia, MODERN PLASTICS *33*, 117 (Mar. 1956).

"Formed sheet styrene copolymers invade metal stamping field," MODERN PLASTICS *33*, 108 (Dec. 1955).

"From design to 3D display," MODERN PLASTICS *33*, 101 (Nov. 1955).

"Engineering a new case," MODERN PLASTICS *32*, 113 (July 1955).

"Plastics' junior giant," MODERN PLASTICS *32*, 87 (Apr. 1955).

"Molds for vacuum forming," MODERN PLASTICS *32*, 124 (Mar. 1955).

"When and why to use drape forming," by G. H. Howell, MODERN PLASTICS *32*, 138 (Oct. 1954).

"Vacuum forming," MODERN PLASTICS *31*, 108 (Aug. 1954).

"Shape a sheet," MODERN PLASTICS *31*, 87 (May 1954).

"Forming of rigid thermoplastic sheet," by R. C. Davenport, Plastics Technology *2*, 232 (1956).

"Vacuum forming of polystyrene sheet," J. M. Hoy, SPE J. *10*, 9-10, 33 (Jan. 1954).

"Vacuum forming of Braille literature," Brit. Plastics *27*, 224 (June 1954).

Plastics Tooling

BY MAX HILRICH* and FRANK L. BOGART†

Plastics tooling interest dates back a quarter-century or longer, but effective applications did not start to emerge until the '40's and it has only been in the last few years that progress has really gone forward. While manufacturers of aircraft, automobiles, and appliances are major users today, plastics tools and dies have found a place in almost every industry concerned with metal-forming or plastics-forming.

World War II created the first big impetus for use of plastics tools, when airplane manufacturers first faced shortages of the metals traditionally used in tooling. Since the initial start, however, the aircraft industry has continued to rely on plastics. One major reason for this has been the fact that, since relatively small numbers of any one model of plane are generally made, the time and expense of machining tools becomes disproportionate in cost.

Automobile manufacturers have turned to plastics tooling because competition dictates frequent and rapid changes in styling. Plastics tools facilitate design revisions since contours can be altered by refacing and other simple methods. In both prototype and production programs, the ease with which plastics tools can be modified helps maintain schedules.

In other fields, initial low cost and fabrication speed of plastics tooling have made it feasible to engineer many new projects. Pilot runs can be quickly and inexpensively started where large investments in metal tooling could not be justifiably risked on untried products.

Materials

Hand-in-hand with the steady increase of application know-how, a big factor in plastics tooling progress has been the development of new and improved materials. Although there has been some experimentation with ethyl cellulose, a thermoplastic material, thermosetting resins have been dominant in all forms of plastics tooling.

Phenolic resins' low cost and handling ease have kept these pioneering materials in some demand. However, in the bulk of applications they have given way to the newer epoxies with their greater strength and durability. Epoxies have also forged ahead of the polyester resins used in combination with fibrous glass and other reinforcements for laminate tools. This is mainly because of the low shrinkage of the epoxies, their better bonding and wetting abilities, and their exceptional stability.

Specific end requirements, however, based on such factors as length of run, degree of dimensional accuracy needed, and stress to which the tools will be exposed, must dictate the final selection of resin. When more than one resin can serve the purpose, relative cost becomes the deciding element.

Combinations of materials are often used. Metal cores increase the compressive strength of plastics-faced dies, while metal inserts can provide a means of piercing and shearing, and can overcome weaknesses in thin sections and sharp radii. Weight and cost can be reduced by making tools with epoxy surfaces and phenolic foam cores. Fillers are used to boost special properties, such as resiliency or abrasion resistance, or as extenders for further lowering materials costs.

Advantages and limitations

The cost advantages of plastics tools over metal tools are most evident when complicated contours are involved that would be extremely expensive to machine. In general, much of the cost savings with plastics tools are derived from production economies rather than from the differences between the prices of plastics and other materials. Lead time when using plastics tools, for example, is considerably reduced, with tools frequently being produced in days instead of weeks. Barbering and finishing are partly or entirely eliminated by using plastics tools, and equipment requirements are considerably less.

Lighter in weight and more resistant to corrosion than metal tools, plastics tools are also more easily handled and stored. Their ability to be modified makes it faster and more economical to duplicate or revise tool designs.

For prototype production and experimental work to test proper die design, or for relatively short runs, plastics tooling can offer maximum convenience at minimum cost. In this sense, plastics tooling can be an adjunct to, rather than a replacement for, conventional metal tooling. The plastics dies, for example, can be used for production or market-testing a product. When results have been determined, the plastics dies can be supplanted by metal dies capable of absorbing higher costs over a long run.

On the other hand, cases exist in which many thousands of metal panels have been successfully drawn on plastics dies based on special heavy-duty resins cast around fillers and inserts. There are even rugged resins in use today that make possible the production of tools which can stand up to foundry blowers and slingers.

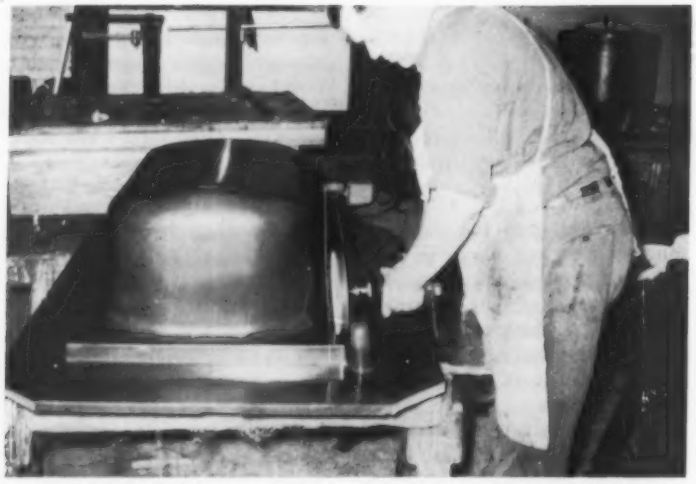
Formulations now about to emerge from the laboratory stage are expected to overcome other deficiencies, e.g., heat resistance and conductivity, that now limit the use of plastics tools and dies.

Basic fabrication methods

Basically, all fabricating methods used for plastics tooling rely on two or three techniques used singly or in combination—casting, laminating, and to some extent splining.

Regardless of what special properties may be incorporated in their formulation, tooling resins

* Research Director, The Marblette Corp., 37-21 30 St., Long Island City, N. Y.
† Sales engineer in charge of the Marblette branch in Detroit.
References were prepared by the editors.



Plastics mold used for vacuum-bag molding of reinforced plastics bathtub reduces tooling costs and cuts down tool-up time. (Photo, The Marblette Corp.)

are generally easily-poured liquids which can be stored in unopened containers. After opening, the resin is blended manually or in standard mechanical mixers with a suitable catalyst.

In casting, the catalyzed resin is poured directly against a model or a mold made from a model, usually after the model or mold has been coated with a parting agent.

In laminating, a gel coat is usually first applied to the prepared form to improve surface properties, e.g., abrasion resistance. When this heavy coating becomes tacky, a lay-up is made on the form by brushing an impregnating resin into successive layers of fibrous glass cloth or other reinforcing fabrics, until the required thickness is reached.

Superior new pastelike troweling and splining resins which will not run off vertical surfaces are applied outside male forms as well as inside female forms.

After curing at room temperature or in an oven, the cast or laminate tool is easily removed from the form.

Casting usually involves higher-cost resins, but the extra expense can generally be compensated for by the minimum amount of time and labor involved. Laminate tools are usually more accurate and have greater tensile and flexural strengths than the cast tools. Advantages of both methods are often combined by making tools with a laminate surface and a cast core.

As in the selection of materials and special-property fillers, the use to which the tool will be put must determine both the choice of tooling method and the need for modifying standard tool fabrication techniques. Among the variations in use today are metal-plastics composites; metal backup for plastics facings; phenolic foam cores bonded to epoxy surfaces; and metal inserts. Inserts are either set in place when a die is cast or else installed later by chipping back an area, pouring resin into the cavity, and inserting the metal before curing the resin.

Differences in the properties and reactions of the various available tooling resins may also dictate shifts in basic tooling methods.

Prefabrication steps

Designing a part to be tooled by plastics begins with several basic steps: sketches of the proposed design; miniature clay models; full-size clay models; and finally, a wood master model.

The wood master itself may be put into service as a mold, or a plastics laminate or plaster splash can be taken off it. An existing metal part is sometimes used in place of a mold. Other materials used in varying degrees as molds include vinyl plastisol as well as glass.

Certain rules for preparation of the molds apply to all the resins used for tooling applications; others vary according to the nature of the material.

The general recommendations are as follows: molds must be thoroughly cleaned; their walls should be thick enough for rigidity and strength, but not so thick that they will lengthen drying and curing times.

Porous molds require drying and sealing. Several coats of a sealant are often applied until a glossy finish is obtained; light sanding with 400 grit paper between each application is another practice frequently followed. If weaves or wave-like surfaces are present, they must be smoothed down. Blemishes are sanded off and hollows filled in.

This close attention to finishing is especially important because of the fact that casting resins accurately reproduce the surface of the mold against which they are cast. Any imperfections in the mold surface will therefore show up as imperfections on the plastics tool. If a "mirror-smooth" finish is desired on the tool, it is advantageous to buff the mold surface to achieve the desired smoothness.

Sealing porous surfaces is followed by high-luster wax buffing and application of a parting agent. Time spent in these mold-preparation procedures will be saved later by elimination of tool-finishing steps.

Nonporous and smooth plastics molds need only be waxed and a parting film applied. Plastisol and glass generally require no parting agents at all.

Metal-forming dies

Many types of tools are made for forming metal sheets of varying thicknesses.

Stretch dies: Plastics stretch dies are among the most prevalent tools of this kind. They often have working face areas of well over 100 feet and are used in conventional stretch presses, where a metal sheet is gripped by clamps and pulled over the die by mechanical or hydraulic power. Plastics dies are particularly sat-

isfactory for this use because they can be made to have a glasslike surface which eliminates die marks on the formed metal parts. They are used widely in the aircraft industry as well as for making refrigerator components and for forming automotive panels.

While laminate shells, cross-ribbed for strength, are sometimes used for stretch dies, casting resin poured into a female mold is the more common technique. A foamed core can be used to reduce the die's cost and weight. In such case, a cured core of foamed phenolic or other resin is suspended in the mold cavity and the casting resin poured around it. An alternate technique is to secure sections of foamed resin to a metal or Richlite backing, then to suspend this in the cavity while the casting resin is poured through holes in the plate.

Draw dies: Plastics draw dies offer savings in initial cost, lead time, and maintenance. They are sometimes made with cast cores and laminate surfaces. Their primary use is for developmental work and the drawing of prototype parts, but they have also been used to draw fairly large numbers of panels from thin-gage steel and aluminum, and in addition have been adapted to short runs of heavier cold-rolled steel.

Hand hammer forms: Plastics hand hammer forms are particularly useful in automotive design programs, where special tools may be needed to produce a few metal parts.

Hand hammer forms may be cast solid, or made by pouring a casting resin over a foam core in a retaining frame. Precision-cast inserts of brass and zinc alloy can provide for exceptionally sharp contours. These inserts may be set in the mold prior to casting and locked into place by slots or bolt heads protruding into the plastic. They can also be set in during a later phase of the operation by chipping out a section of the form and casting the inserts in place with the plastic.

Drop hammer dies: Plastics are often combined with other materials in making drop hammer dies. In one successful method, a filled resin is cast inside a laminate for the bottom half of the die. This part of the die is then placed in a frame to serve as the mold for casting a resilient epoxy face on the corresponding punch, which will have a lead or Kirksite core. Since a parting agent is used, the two halves of the drop hammer can be easily separated.

Other variations in drop hammer die design include plastics punches with metal bottom dies, punches with laminate faces over cast bodies, and punches with steel weldments for added strength.

Rubber press hydro-forming and hydro-static dies are made of both casting and laminating resins for forming metal parts into odd shapes.

Fixtures, jigs, and gages

Construction of fixtures and gages accounts for a large amount of plastics tooling materials.

Flange-checking fixtures fabricated of plastics are accurate and inexpensive, since they are made directly from the master model or its duplicate. They are used to check contour flanges and hole locations of parts.

Lightweight, inexpensive, yet durable, plastics fixtures and gages are made to duplicate complicated shapes by hand lay-up of epoxy resins and fibrous glass cloth directly onto master models.

Plastics holding forms can be made by suspending an actual part in a frame and waxing and coating it prior to pouring casting resin around it. After curing, the part is separated from the casting by sawing the casting in two. Each half of the casting will retain the contours of the piece being duplicated.

Similarly, by casting or laminating against a part, plastics holding fixtures for secondary operations can be made, as can other fixtures for trim, drill, routing, assembly, plating, welding, and other functions.

Duplicates and models

Laminated plastics duplicate models and Keller models are widely used, particularly in the automotive industry.

Gel coats and laminating resins are applied over a wooden die model. A framework of tubing or sheet stock is then bonded on to serve as a spotting fixture. A laminate skin is made on this spotting rack, and a framework and base, as well as locating pads, are provided.

Duplicate models made in this way are often sent out by automobile manufacturers to their various accessory makers and assembly plants for reference.

Laminated or cast plastics study parts are used to plan design, tooling, and assembly operations.

Foundry applications

Plastics resins, particularly the epoxies, are beginning to make deep inroads into foundry and pattern-making work.

Unfilled and filled casting res-

Cast plastics dies, here used to draw a complex automotive part, are ideal for developmental work because of ease with which design changes can be made





Resin-impregnated fibrous glass cloth is laid up against a die model in a frame in initial step in production of a Keller model. (Photo, Marblette)

ins, laminating resins, and troweling resins are becoming more and more popular as materials for patterns that do not require the costly machining and time-consuming finishing of metal patterns.

Plastics resins are also being widely adopted as a coating for wooden patterns and in foundry repair work for patching worn spots in metal core boxes.

Particular savings are gained with plastics materials when there is a need for multiple patterns, or for many duplicates of core boxes, core prints, or match plates.

Specially - developed plastics materials are used for fabricating core driers that are used in dielectric baking.

Laminating resins are frequently used with abrasion-resistant gel coats for constructing large and relatively complicated patterns.

Plastics-forming tools

Plastics tooling for plastics fabrication finds a major outlet in vacuum forming and in other processes for shaping plastics films and sheets by applying heat and pressure.

Vacuum forming plastics dies can be fabricated faster than machined metal dies. Their dimensional stability permits them to be used interchangeably on the press platen for multiple forming, and they faithfully reproduce even the most intricate detail. Mass production is facilitated by the ability of plastics dies to be revised or repaired quickly and easily.

Cast and laminated epoxy production molds have also been used for forming large and small reinforced plastics parts—by vacuum bag molding and other techniques. Among the reinforced plastics items turned out on plastics molds have been one-piece bathtubs and huge sections of prefabricated home swimming pools.

Plastics matched dies are used for low-pressure molding of plastics components. Plastics pattern duplicates have helped speed up mass production of products made by latex-dipping. Plastics tools have also been used for forming foamed plastics parts such as automobile cushioning and crash pads.

Forming acrylic

Both cast plastics tools and laminated reinforced plastics tools are used to shape precut acrylic sheets, particularly in the aircraft industry. These tools form windows, canopies, astrodomes, landing light covers, and other plastics parts. The basic technique used is manually to drape the preheated acrylic sheets over the forming tool. An overhead clamp holds the sheet while a vacuum circuit in the tool pulls the sheet into the required shape, holding it in place against the tool while it cools and hardens into the desired form.

Heated acrylic sheets are also formed by the application of pressure, without the use of a vacuum, on cast phenolic and epoxy dies. This technique has been used in the production of very large plastics signs and displays which frequently have irregular contours.

Casting and laminating resins are also used in the aircraft manufacturing field for plastics-forming applications requiring great accuracy and close tolerances.

Advances and prospects

Future significant applications in the field of plastics tooling are expected to develop as a result of the work now being done on new plastics resins. Epoxy resins and special high-heat-resistant resins seem to be receiving the major share of attention.

Forming of hot metals, for example, is becoming more feasible with the introduction of new tooling resins with a heat resistance of approximately 600° F.

With such heat resistance, and with the development of resins capable of withstanding more impact and abrasion, foundry field uses should continue to expand. Experiments in fabrication of shell mold patterns are currently making headway.

Production molds of plastics with improved heat transfer should also create further inroads in the plastics-forming field, particularly in injection molding.

Development of epoxy rubber-like resins that have high-impact resistance and do not harden with age is already leading to increased uses for plastics drop hammer forms.

References

For further information on the materials used in tooling, consult the Subject Index, and the Directory Index, p. 1018.

"Metal working swings to plastics tools," MODERN PLASTICS *32*, 85 (Sept. 1954).

"Why epoxy resins for laminated tooling?" J. Delmonte, Materials & Methods *40*, 93-95 (Aug. 1954).

Casting Plastics

IN THIS SECTION

Casting Acrylics 747
Thermosets,
Liquid and Cast 750
Plastisol Molding 760
Potting and Encapsulation of Electrical Components . 753
Flexible Molds for Casting .. 758

CASTING ACRYLICS

BY JOHN O. BEATTIE*

The casting of plastics materials differs from other molding techniques in that the starting material is a liquid monomer which solidifies by polymerizing within a mold to the finished shape. Casting sheets is usually done at moderate temperatures.

There are many different monomers which can thus be cast into sheets. The best known of these is methyl methacrylate, the polymer of which has been sold as cast sheet. Sheets produced by casting have superior optical properties[1], since their surfaces reproduce exactly the polished surfaces of the glass molds in which they are cast. Other properties—tensile and impact strength, surface hardness, and thermal and electrical coefficients — compare favorably with molded sheets.

Methyl methacrylate

Casting-grade methyl methacrylate monomer is a water-white liquid which has the following physical properties:

Specific gravity	@ 25° C.	= 0.940
Viscosity	@ 25° C.	= 0.56 cp.
Refractive index	n_D^{25}	= 1.4118
Boiling point	@ 760 mm.	= 100-101° C.

The chemical formula of methyl methacrylate is

$$CH_2=C(CH_3)-C(=O)-OCH_3$$

and since the molecule contains only one active group, methyl methacrylate polymerizes in linear chains to yield thermoplastic sheets.

Of all the materials that can be cast into sheets, methyl methacrylate has the most interesting properties. Cast methyl methacrylate sheets have good tensile and impact strengths and excellent weathering properties. They can be readily machined, and on more or less conventional equipment. The material can be formed to almost any simple or compound curvature, and its high optical clarity, luster, and sparkle make this a premium material.

As received from the manufacturer, methyl methacrylate monomer contains 20 to 60 p.p.m. of hydroquinone inhibitor. In order to obtain maximum clarity, it is necessary to remove the inhibitor contained in the monomer to less than one part per million. This cannot be accomplished by ordinary distillation, since the hydroquinone itself is somewhat volatile. A carefully designed fractionating column is required.

Uninhibited methyl methacrylate monomer can be stored for some time if it is refrigerated at around 4° C., but it is best not to accumulate large quantities once the inhibitor is removed.

Casting molds

In preparing a casting mold, two sheets of glass are carefully cleaned to remove all dirt and lint which could create flaws in the finished cast piece. This glass can be selected plate glass, free of scratches and other surface imperfections, or tempered glass (Herculite, Tuf-flex). Tempered glass has the advantage of great strength and resistance to thermal shock, though it is by no means as unbreakable as might be supposed before one has actually handled it.

The tempering of glass plates is covered by a considerable number of patents, and all plate glass which is tempered in this country is done so under license[2]. Furnaces can be obtained to temper plates of glass, but problems of yield, flatness, and high initial cost have to be considered carefully. It is also entirely possible that homemade tempering of glass plates can be less effective in producing ultimate hardness than that obtained from commercial manufacturers.

The two plates of glass, carefully cleaned and dried, are placed face to face and spaced the required distance apart by means of a "gasket" which can be an extruded elastomeric material such as plasticized PVC, or a solid material such as aluminum or steel covered with paper and cellophane tape. Since, however, all monomers undergo considerable shrinkage as they polymerize, use of solid gasket material requires that the gasket be removed during cure to permit the glass plates to come together and allow for the shrinkage.

The mold, or cell, composed of the two plates of glass separated by the gasket, is then clamped together, with one corner of the mold normally left open for the introduction of the resin monomer. The clamped mold is then laid in an inclined position for filling.

Pouring the resin

The mold is loaded by pouring the resin through a specially designed funnel (Fig. 1, p. 748) into the corner opening. Since the plates of a glass mold of any size are quite flexible, it is necessary to introduce exactly the correct weight of resin to get a finished sheet of uniform thickness. Fill-

* President Polycast Corp., 69 Southfield Ave., Stamford, Conn.

References were prepared by the editors.

[1] The term "optical properties" is a catch-all which includes such properties as transmittance of visible and ultra-violet light, haze, angular deviation, and minor defects. If the sheet is to be accepted for aircraft applications it must meet the rigorous requirements of MIL-P-5425A. A ¼-in. sheet, for example, must have 90% transmission of visible light but must not transmit more than 5% of incident UV in the 290- to 330-mμ range. Its haze value must be less than 3% and it cannot average more than one minor defect for each 4 sq. ft. A minor defect is a small bubble, a scratch, an imbedded particle. It must not deflect light more than 7 min. of angle from a perfect straight-line path. A 7-min. deflection would cause an object 1 mile distant to appear 10 ft. out of place!

[2] American Securit Co.



Fig. 1: Accurately weighed-out sirup is poured from stainless steel pitcher into tilted mold through funnel especially designed for this operation

ing the mold to the top would cause the glass to bow out under the hydrostatic pressure of the liquid, and would yield a sheet considerably thicker at the center than at the edges.

The mold having been charged, the opening in the gasket is closed and the mold lowered to the horizontal position. The operator taps the mold (Fig. 2, below) to spread the charge and the mold is transferred to a rack and placed in an oven where the resin is cured. The curing temperature, of course, depends on what resins and catalysts are being used, but in general it is between 45 and 70° C. In many cases, a single fixed curing temperature is not satisfactory; if it is necessary to change the temperature during the cycle, a suitable time-temperature control must be installed on the curing oven.

Curing time

The time required to produce a full cure in the mold depends not only on the temperature, but also on the catalyst being used, and on the sheet thickness. Acrylic casting resins evolve heat very suddenly during the polymerization; it is just as much the function of the oven to remove this heat as it is for it to provide the temperature required to start the reaction. It is a good general rule in designing casting ovens to have as high an internal air velocity as possible. If the air velocity is not high enough to remove the heat of reaction, the temperature of the casting will rise. It can easily rise high enough to destroy the sheets being cured; in extreme cases, when the thermal shock is of sufficient magnitude, the glass molds may actually shatter.

A possible method of absorbing exothermic heat, at least in the case of methyl methacrylate, is to mix powdered polymer with monomer to produce the casting sirup.[8] The exothermic heat given off by the monomer is almost counterbalanced by the heat of the solution of polymer as it dissolves in the monomer. It is claimed that thick methyl methacrylate castings can be produced in this manner and that very little exothermic heat is given off.

For most materials up to ⅛ in. in thickness, curing time can be held to approximately 16 hours. But thicker materials may require more than 16 hr. curing time, since it takes much longer to remove the exothermic heat from a thick piece than from a thin one. In the case of 1-in. and thicker slabs, the curing time may be as much as a week.

After curing is complete, the molds are withdrawn from the oven and cooled, the clips and the gasket are removed, and the glass plates are separated from the now-solid plastic sheet. The plastic surfaces, faithful reproductions of the polished glass surfaces of the mold, are optically clear and ready for use without further processing. Usually, the plastic sheets are masked prior to shipment. Masking consists of applying paper coated with pres-

[8] U.S. Patent 2,468,094.

Fig. 2: Operator lowers tilted mold to the horizontal while tapping it to assure even spread of the charge through the entire mold



-sensitive adhesive to both sides of the plastic sheet. A sheet so protected can be fabricated without risk of marring the mirror-smooth surfaces.

After the plastic sheets are removed from the molds, the glass plates go back to the cleaning and assembly operations previously described, and the cycle is repeated. The plates of glass can be used hundreds of times if they are properly cared for, and the mold cost per cast sheet is very low.

Shrinkage in the mold

As already mentioned, any mold in which resin monomers are to be polymerized must be designed to allow for the shrinkage which occurs during the cure of the resin. Polymerization shrinkages of acrylic resins range from 15 to 21% and the shrinkage must be taken up by allowing the two glass plates to come closer together during the curing process. If they cannot come together, the sheet will separate from the plates and will be spoiled.

The material naturally seeks to shrink equally in all directions. In the early stages this is possible because the sirup has a relatively low viscosity and flows readily under the stresses set up by volume changes. Later, however, the viscosity becomes very high and at the same time the sheet adheres to the mold plates. Movement in the planes parallel to the plates is severely restricted, so all cast sheets end up with cured-in stresses. These stresses can be alleviated, or at least greatly reduced, by annealing the cast sheet after it is out of the mold. Methyl methacrylate sheets, for example, are normally annealed by reheating to about 150° C. and then cooling slowly. During this procedure the sheets shrink about 2% and the cured-in stresses are almost completely relieved.

The annealing or shrinking of methyl methacrylate sheets is quite an art, since even slight variation in conditions will produce out-of-flatness or incomplete annealing. Localized optical flaws appear in shrinking which are invisible as the sheets come out of the mold. The would-be manufacturer of cast methyl methacrylate sheet would do well to examine this part of the process most carefully.

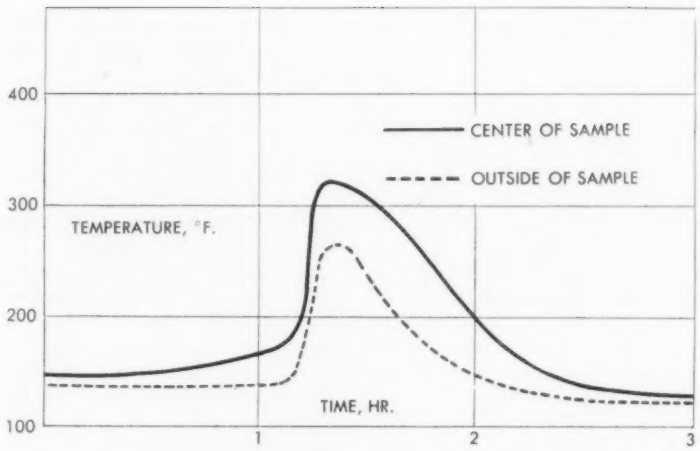


Fig. 3: Typical curing-reaction exotherm curves for methyl methacrylate. This particular sample was a 2-in.-diameter cylinder that was cast in a glass jar immersed in water at 50°C. "Outside" temperature was measured by thermocouple that had been placed at the resin-glass interface

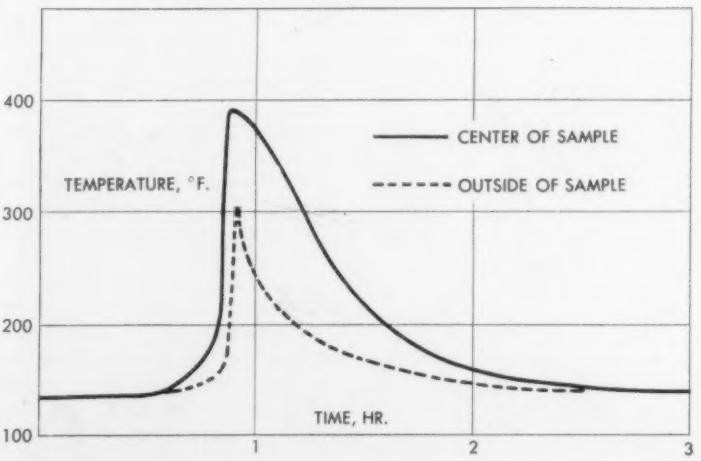
Prepolymerization

Another way of reducing the bad effects of shrinkage in the mold is to reduce shrinkage. To this end, most thermoplastic resins are prepolymerized to a "casting sirup." The use of such a sirup not only lessens the polymerization shrinkage in the mold (because some polymerization shrinkage has already taken place outside of the mold), it also offers three other advantages: 1) the curing time is reduced; 2) less exothermic heat is evolved during the cure; and 3) the sirup is less likely to leak from the mold.

When handling methyl methacrylate monomer, for example, the uninhibited monomer (which is a clear, colorless liquid of about the same viscosity as water) is heated in the presence of a catalyst, whereupon it begins to polymerize, gradually becoming more and more viscous until it reaches the same consistency as molasses (in June, not January!).

One technique for performing this operation is to heat the ma-

Fig. 4: Temperature-time curves for methyl methacrylates with 10% methacrylic anhydride. Temperature rose much higher than with pure methacrylate (see Fig. 3, above), although the same conditions obtained. The rate of rise at the surge is approximately twice as fast



terial in batches of about 150 lb. in steam-jacketed kettles. A small amount of azo catalyst is added to the mix, which is then heated to the required temperature for the required length of time. During this period, the material is mechanically agitated.

Suitable catalysts for this purpose include benzoyl peroxide, t-butyl perbenzoate, lauroyl peroxide, isopropyl percarbonate, and other similar types of catalysts. Recently a proprietary catalyst, azoisobutyronitrile,[4] has been suggested for this purpose.

Thickening of methyl methacrylate monomer to a sirup requires careful control, particularly during the cooling phase. With inadequate cooling facilities, the contents of the kettle may heat up beyond their boiling point, causing the vapors of methyl methacrylate to boil out of the kettle, and creating a very serious fire hazard.

Since methyl methacrylate monomer and casting sirup have a specific gravity less than 1, a fire of this type cannot be extinguished with water. A mixing room of this type should contain other means of extinguishing such fires as they occur. All fixtures in such a mixing room should also be explosionproof.

Rate of exotherm

Figure 3, p. 749, shows graphs of temperature *vs.* time during cure of a cylindrical methyl methacrylate casting 2 in. in diameter. For the first part of the cycle, virtually no heat is given off. At a crucial stage, the viscous liquid suddenly becomes an undercured solid, and at this point practically all of the heat of polymerization is liberated. An ordinary curing oven which would be satisfactory for the other materials, cannot remove fast enough the big slug of heat which is evolved with almost explosive rapidity. If the sheet is a little too thick for the oven to handle or the catalyst concentration is a little too high, the sudden burst of heat begins to boil the monomer and large bubbles form between the glass plates. The internal pressure mounts fast and the costly glass molds are likely to shatter under the effect of the thermal shock.

Special care must be taken to remove this heat. Since the amount of heat given off is proportional to the amount of material in the oven, it is the large batches of material and the thicker sheets that are the most difficult to keep under control. Unfortunately, loss of control is most costly when control is hardest to maintain—when the oven is running near its capacity both in molds and in resin. In curing methyl methacrylate, therefore, air velocities and air turnover in the oven must be as high as possible in order that the heat that is given off at the critical point of the curing cycle may be quickly removed. As an extra safeguard, the oven should have an external vent so that cold air can be brought in as needed.

Since water is a much better heat-transfer medium than air, an extra degree of control is gained by curing thicker sheets, e.g., ½ in. or over, in a water bath. It is only necessary to keep the molds in the water bath until the resin has safely passed the critical point. After this, the cure may be completed in air.

Copolymerization

Methyl methacrylate can be copolymerized with a number of other monomers. It copolymerizes readily with most of the available acrylate and methacrylate esters, as well as with styrene and vinyl acetate. Copolymerization with cross-linking materials such as CR-39, diallyl diglycolate, diallyl maleate, etc., yields infusible polymers and properties intermediate between those of the cast pure resins. Some of these copolymers are valuable commercially because of their increased solvent and craze resistance, though this is obtained at the expense of formability. In some cases, such as the copolymerization of methyl methacrylate with methacrylic anhydride, the problem of exothermic heat is greatly aggravated, so that the difficulty of safely casting some of these materials becomes very great. The temperature-time graph for the curing of a 2-in. cylinder of this copolymer is shown in Fig. 4, p. 749. Note how much higher the temperature peak is than in Fig. 3, p. 749, for methyl methacrylate alone (255° F. rise in center *vs.* 165° F.). Note also that the slope of the peak in Fig. 4 is steeper—the rate of heat-up is about 1.5 times as fast.

References

"Casting plastics sheet," by J. O. Beattie, MODERN PLASTICS 33, 109 (July 1956).

OSRD Report No. 4417, Contract OEMsr-70, 1945.

Riddle, E. H., "Monomeric acrylic esters," 1954. New York: Reinhold Publishing Corp.

[4] Refer U. S. Patent 2,471,959, May 31, 1949, Hunt to Du Pont.

THERMOSETS, LIQUID AND CAST

BY MAX HILRICH*

New thermosetting compounds are constantly being developed to supplement the wide choice of cast epoxy, phenolic, and polyester resins that are available to industry.

Distinction should be made between those resins which are furnished to fabricators in already-cast form and those supplied in liquid form for casting and related uses. In the former area, the phenolics retain their dominance for use in fabrication of consumer items and many kinds of parts for industrial use. The liquid phenolic formulations are used primarily for casting and serve such special needs as bonding, laminating, sealing, surfacing, and potting. Liquid epoxies have become well-nigh indispensable for plastic tooling, but phenolics also are still functioning in tooling programs. Polyester and epoxy liquid resins are widely used to impregnate electrical and electronic components (see "Potting and Encapsulation of Electrical Components," p. 753). By combining fibrous glass and other reinforcing materials with epoxy and polyester liquid resins (and to some extent with phenolic

*Research Director, The Marblette Corp., 37-21 30 St., Long Island City, N. Y.

References were prepared by the editors.

resins), exceptionally strong products can be turned out by the manufacturer.

Cast phenolics

Laboratory formulation is followed by 14 to 18 hr. of compounding in huge kettles. High heat condenses formaldehyde and phenol in the presence of a catalyst, and excess moisture is removed by vacuum distillation.

Coming from the kettle in pure form, the required phenolic compound is poured into a heated lead mold produced from a steel arbor used as a master pattern. It is then oven cured and removed from the mold. A diversity of standard and special shapes is produced in this way—cylinders, tubes, rods, sheets, slabs, and other forms.

These phenolic castings are hard and rigid, with high strength and good resistance to combustion, fungi, acids, and extremes of temperature. They are readily machined with standard tools.

Cast phenolics owe much of their popularity to eye appeal. They range from pastel to dark colors, in varying degrees of opacity or transparency, and with mottled effects available to simulate marble and gems. They are used for fabricating costume jewelry, umbrella and cutlery handles, trophy bases, cigarette holders, hairbrush backs and shaving brush handles, ornamental bottle tops, and other items whose acceptance relies on visual attractiveness.

From the fabricator's point of view, a prime advantage of phenolic castings is their ability to be machined as easily as hard woods, with low setup costs. Standard tools are used in finishing the cast phenolic shapes by wet and dry grinding, sawing, drilling, tapping, turning on lathes and spindles, sanding, lapping, hand polishing, buffing, and tumbling.



Phenolic castings are available in a range of marble-like mottled effects that make them useful for trophy bases, lighters, etc. (Photo, Marblette)

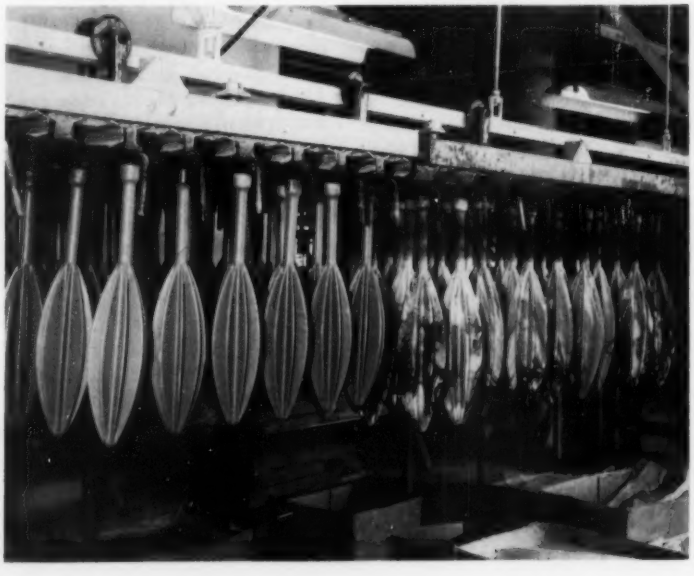
Casting resins

Versatility and relatively low cost have spurred the use of *liquid phenolic resins* for casting. They have long shelf life when stored in cold rooms in unopened containers. When about to be used, they are brought to normal room temperature. In an acid-resistant container, the resin is mixed with an appropriate hardener, either manually or mechanically, at low speed (generally 30 to 60 r.p.m.) to entrap a minimum of air in the mixture, dispose of bubbles, and forestall crazing of the finished casting. Polymerization usually is achieved with controlled heat, but room-temperature cures or time-saving combinations of oven and room cures also take place.

Liquid phenolic resins produce castings with good dimensional stability, low shrinkage, and high resistance to heat and acids.

Liquid epoxy casting resins exhibit an even more striking range of advantageous properties. In addition to negligible shrinkage and dimensional stability, they offer strength and rigidity, resilience (in special formulations when required), ability to stand up under abrasion and impact, and resistance to crazing, chipping, and cracking. They are found to be very durable, even when extreme wear is anticipated, as in applications like draw dies

Metal mandrels coated with a protective epoxy resin do not develop pits and fissures when dipped into hot latex to produce beach balls. (Photo, Marblette)



and other metal-forming tools, routing fixtures, and foundry dies. They require little or no finishing.

Except in special circumstances, such as in the manufacture of special-purpose tools, epoxy resins require no heat for polymerization. They ordinarily set at room temperature, with the aid of noncorrosive hardeners. Some manufacturers further simplify curing by prepackaging resins with the required amount of the proper catalyst.

Unlike phenolic and epoxy casting resins, which are available in standard as well as special forms, *polyester resins* are most often custom formulated to meet specific requirements. Usually furnished as comparatively thin liquids, they must be blended with small and carefully measured amounts of catalysts to assure proper cure.

However, polyester resins for tooling uses are limited by their inability to match the other resins in such properties as high strength and low shrinkage, but they are prominent in potting and reinforced plastics applications.

Tooling applications

Plastic-forming and metal-forming tools may be made entirely of one resin, a combination of resins, or a combination of plastics and other materials. For example, epoxy hand hammer forms used in prototype production to establish a final die design may have a phenolic foam core to reduce cost and weight. Heavier-duty tools, allowing for complex contours and standing up to longer runs, may have a laminated face built up with a gel coat. Metal inserts may also be used at points of stress. Durable drop hammer punches have been made by casting an epoxy face on a lead alloy body.

Plastic gages, fixtures, draw and stretch dies, rubber press forms, hydroforming dies, and other tools are now standard production adjuncts in the automotive, aircraft, appliance, and other industries. Foundries have learned that improved epoxy resins provide tools that can stand up to blowers and slingers, and are using an increasing number of plastic patterns, match plates,



Cast plastic vacuum forming die is produced by pouring liquid resin into plaster model. (Photo, Marblette)

core boxes, and core prints. (For a complete discussion on the use of plastics tools for forming metal or plastics, see "Plastics Tooling," p. 743.)

Plastic tools have gained acceptance because their light weight permits easy handling, they can be stored without danger of corrosion or rust, and they create cost savings by reducing lead time and virtually eliminating finishing. Since phenolic and epoxy tools can be readily revised by recasting, refacing, chipping away, or adding material, quick changes can be made.

Not only do plastic tools save many man-hours, but they also bypass the complex equipment required to produce metal and wood tools. They are constructed principally by casting, but laminating is also involved. Many tools with cast cores have laminated faces for added strength.

Epoxy and phenolic tools have been fabricated in days or even hours. While particular applications may entail variations, a basic method begins with making a plaster mold from a model. A sealant and parting agent are then applied to the mold and the liquid resin is poured into the mold cavity. After curing, the finished part is separated from the mold and can be put to work with a minimum of delay.

Reinforced plastics

Thermosetting resins, primarily epoxy and polyester resins, can be combined with glass fibers and other fillers and reinforcing materials in the manufacture of industrial or architectural components and durable consumer products that range from luggage to boats, automobile bodies, and swimming pools.

A recent trend has been toward the use of epoxy production molds in reinforced plastics fabrication.

Laminate tools are frequently constructed by laying successive thicknesses of plastic resin and a reinforcing material onto a form. Such tools are often used to produce items which demand painstakingly close tolerances, such as wing tips and jet radomes for civil and military aircraft.

Special uses

Thermosetting resins now come in so many forms for so many different purposes, that any listing of their uses would lose its up-to-dateness almost as soon as it was written.

However, among recent strides made by these resins, particularly by the epoxies, are:

Rubber-like resins and resins that combine resiliency and toughness for gasketing, etc.

Maintenance paints and protective varnishes with tested ability to guard machinery, piping, and steel and concrete structures from the adverse actions of fumes, fluids, acids, alkalies, solvents, caustics, and corrosives. These coatings adhere firmly to virtually all surfaces. They are especially adaptable to latex dipping where they smooth the finish of metal pattern duplicates and prevent development of pits and fissures during repeated immersion.

Dimensionally stable and durable cast and laminate dies for thermoforming processes.

Low-viscosity epoxy resins particularly suitable for vacuum-bag and contact-pressure laminating techniques.

Resins with putty-like consist-

...y, for troweling and splining applications, that can be spread on vertical or horizontal surfaces.

References

"Low-cost molds for short runs," by A. M. Creighton, Jr., MODERN PLASTICS *33*, 121 (Nov. 1955).

"Potting and encapsulation," by F. G. Firth, MODERN PLASTICS *33*, 125 (Apr. 1956).

"Drop hammer dies," MODERN PLASTICS *32*, 130 (Aug. 1955).

"Where and how to use epoxies," by J. Formo and L. Bolstad, MODERN PLASTICS *32*, 99 (July 1955).

"Casting epoxies at N.R.L.," MODERN PLASTICS *29*, 94 (Oct. 1951).

POTTING AND ENCAPSULATION OF ELECTRICAL COMPONENTS

BY F. G. FIRTH*

Experience has shown that most failures in electrical devices are the result of insulation breakdown, caused by heat, aging, or the presence of voids, and by a contributing mechanical fatigue of the insulation by scraping, bending, or by vibrational forces in rotating devices, such as motors and generators.

The solution to this problem is to completely impregnate and cover exposed current-carrying circuits with a 100% solids, low-shrinkage, high-mechanical-strength, high-dielectric-strength material that is thin enough to penetrate the structures and can set up hard within a reasonable length of time. A useful class in this area is called potting resins.

*Consulting Chemist, 3221 Barry Ave., Los Angeles 66, Calif.

References were prepared by the editors.

Encapsulation is the covering of a device with an electrical insulating material, whereas potting is the complete penetration of the voids in the device with the insulating resin.

Available resins

Resins suitable for electrical impregnation are either thermosetting or thermoplastic. The terms are somewhat misleading, however, and have little to do with the actual service temperature of a given material. Teflon or glass could be called thermoplastic materials, and yet they have much higher useful service temperatures than, say, a thermoset polyester. The most practical materials are discussed below.

Phenol-formaldehyde resin: This material is available for potting use as a thick sirup which can be catalyzed. Polymerization will produce condensation by-products and water that must be removed in order to produce a void-free casting. This requires a long, slow cure and application of vacuum. The electrical and mechanical properties of the finished polymer are not very good and the shrinkage of the polymer is quite high.

Polyesters: The term polyester covers a wide range of materials that have one thing in common: the copolymerization agent employed. For electrical impregnation purposes monomeric styrene is used, which permits a low-viscosity liquid to be made. This may be polymerized with organic peroxides. For compression molding, the copolymerization agent is

Diagrammatic representation of potting by vacuum method, showing the successive steps in the process. Assemblies to be potted should be prebaked before being covered with resin, or else considerable foaming action will take place

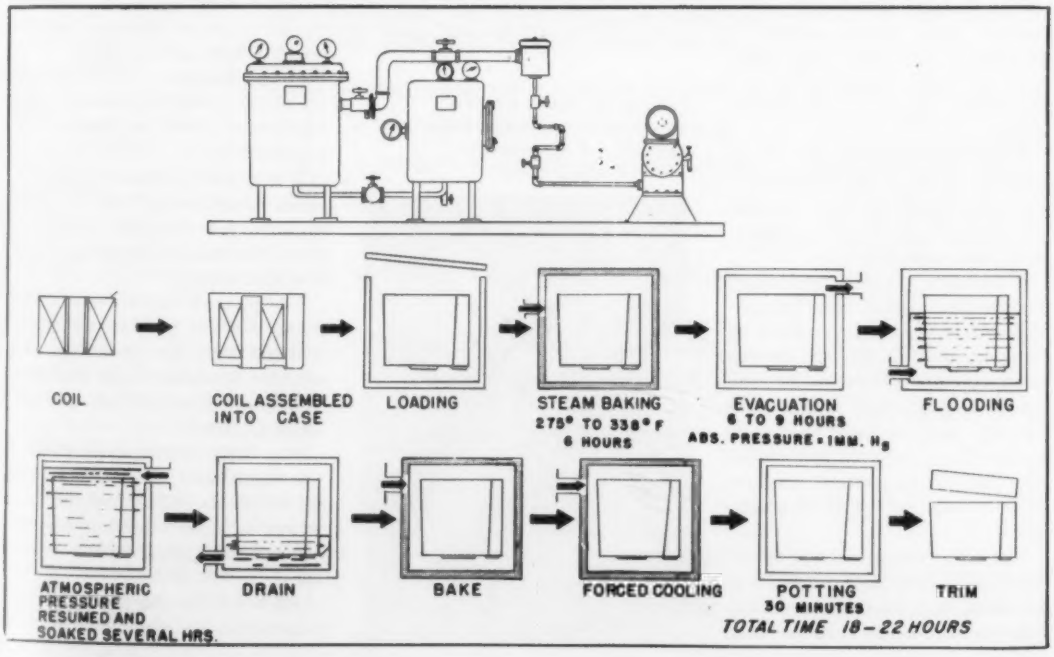


TABLE I: Properties of potting resins

Impregnating sirup	Viscosity	Storage life	Curing temp.	Curing time	Vol. shrinkage	Type of catalyst	Possible sources
	cp.	Mos.	°F.	Hr.	%		
Phenol-formaldehyde	2000-50,000	1-6	120-180	6-48	5-20	Acid	Durez Plastics Div., Hooker Electrochemical Co.; The Marblette Corp.; Bakelite Co.
Allyl	15-100	4-12	150-212	48	8-13	Peroxides	Columbia-Southern Chem. Corp.; Shell Chemical Co.
Polyesters	500-20,000	1-12	70-300	1-12	5-20	Peroxides	Bakelite Co.; Naugatuck Chemical Co.; Rohm & Haas Co.
Styrene	50-20,000	1-6	100-200	10-25	8-20	Peroxides	Emerson & Cuming, Inc.; The Dow Chemical Co.; Monsanto Chemical Co.
Acrylics	4-100	1-6	100-160	24-50	10-20	Peroxides	Rohm & Haas Co.; Du Pont; Bakelite Co.
Isocyanates	20-1000	12-24	70-200	1-12	0.5-1	Condensation	National Aniline; Mobay Chemical Co.
Epoxy	1000-20,000	24+	70-400	1-4	0.5-2	Tert. amines	
						Condensation Anhydrides	Shell Chemical Corp.; Bakelite Co.; Ciba Co., Inc.
Silicones	5000-20,000	6-12	300	2-20	1-2	Amines	
						Condensation	Linde Air Products Co.; The Dow Chemical Co.

Cured resin	Specific gravity	Tensile strength	Compressive strength	Arc resistance	Dielectric constant	Dielectric strength	Rockwell hardness	Heat-distortion temperature	Power factor at 60 cy.	Power factor at 10^6 cy.
		p.s.i.	p.s.i.	sec.		v./mil		°F.		
Phenol-formaldehyde	1.30	5000	12,000	100	5-6	130-230	M 70-110	240	0.33	0.05
Allyl	1.3	5000	20,000	100-200	3.5-4	200-400	M 90-100	150-180	0.02	0.01
Polyester	1.0-1.4	6000-10,000	25,000	120	2.5	200-500	M 70-100	100-400	0.003	0.005
Styrene	1.05	6500	13,000	No track	2.59	600	M 80	160	0.00098	0.0008
Acrylics	1.18	10,000	13,000	No track	3.5	300-500	M 80	150	0.05	0.02
Isocyanates	1.4	1000	(no rupture)	No track	2.86	360	Shore 90	Flexible	0.003	0.008
Epoxy	1.2	12,000	16,000	100-180	3-5	380-400	M 80-100	180-310	0.001	0.02

diallyl phthalate, used because of its higher vapor pressure.

The polyesters themselves are either solids or very viscous liquids, and the addition of styrene reduces the viscosity. Unfortunately, the more styrene is used, the higher the shrinkage upon cure, which may be as high as 10% by volume.

This shrinkage, combined with poor wettability of surfaces, gives results that are not all that can be desired. The solvent action of monomeric styrene upon some wire enamels is rather severe and can cause a prevalence of shorted turns.

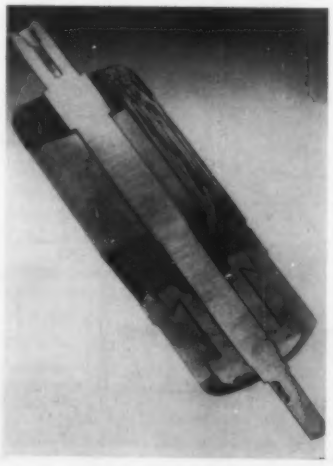
Silicones: The silicones include a wide variety of chemical structures that have little in common other than the presence of chemically combined silicon.

Since they are expensive, they are used in potting only for special jobs that cannot be done by cheaper products. Silicone formulations are available to make casting or impregnating resins, elastomers, and resilient or rigid foams. The materials are generally difficult to process, and are used mainly for Class H conditions.

The disadvantages are poor solvent resistance, poor adhesion to surfaces, and long curing times. Some of the advantages are good properties at high and low temperatures, high thermal conductivity, slow combustion rate, and good ozone resistance. Electrically, they rate fair to good.

Polyurethanes: The reaction of a diisocyanate with polyfunctional groups can produce materials that will range from elastomeric to rigid, and may either be dense solids or foams. Depending upon the nature of the functional reactants, there may be produced polyurethanes, polyureas, polyamides, or a complex structure of all three.

Epoxy-potted motor armature, sawed in half to show thoroughness of impregnation. (Photo, Epoxylite Corp.)



For an impregnating, coating, or casting resin, tolylene diisocyanate is commonly employed because of its availability and lower cost. The reactant is usually a polyester with a low acid number, and hydroxyl terminal or intermediate groups, for cross-linking with isocyanate.

A simple example of such a material is castor oil, which contains three hydroxyl groups, spaced along a long carbon chain.

Small amounts of a tertiary amine or cobalt naphthenate are sometimes added to shorten the cure cycle.

The group is characterized by excellent adhesion, ability to wet surfaces, low viscosity, good electrical resistance, toughness, and low shrinkage.

For printed circuit boards, the polyurethanes provide an excellent material for protecting the exposed elements from abrasion, water, solvents, and low-temperature cracking.

The high impact resistance of the elastomeric types is very useful in missile and aircraft circuits, where extreme vibration and acceleration stresses are encountered.

All in all, the polyurethanes are very versatile and useful mate-



Encapsulated stator for a large random-wound motor which is to be used in a metal grinder. (Photo, Epoxylite Corp.)

rials for potting and encapsulation, when they are correctly employed.

Epoxy resins: These resins are probably the most versatile and most widely useful of the available compounds. The uncatalyzed resin is offered in a number of forms, ranging from 250-cp. liquids to high-melting-point solids. The chemistry and mechanisms of cure are well understood, and highly reproducible results can be obtained with normal care.

The useful pot life and final properties are determined by the class of resin and the curing agent used. The liquid resins, which are most commonly used for impregnation, can be polymerized with either a condensation-type curing agent, or with a catalyst. The former can be an aliphatic or an aromatic diamine, such as diethylene triamine or paraphenylene diamine. Condensation hardeners of another type are the acid anhydrides, such as maleic, phthalic, or pyromellitic anhydride. The catalyst-type curing agents are usually either tertiary amines such as piperdine, or an active Friedel-Crafts catalyst such as boron trifluoride. Free alkalies such as sodium hydroxide can also promote polymerization.

Catalyst-cured systems usually employ about 1% of the catalyst, whereas for a hardener cure, between 5 and 50% of the total volume might be used, depending on the hardener and resin used.

Generally it may be said that the amine-cured system has the



custom extrusions

CRESCENT plastics

for every purpose!

• ENGINEERING & DESIGN SERVICE
• MODERN PRODUCTION FACILITIES
• TOOL & DIE MAKING DEPARTMENT

assure you

quality - service - low cost

Materials for any Application:

POLYSTYRENES
POLYETHYLENES
VINYLS
ETHYL CELLULOSE
BUTYRATE
ACRYLIC
ACETATE
KRALASTIC
CYCOLAC

SEND FOR CATALOG



CALL ANY OF THESE CRESCENT CUSTOM REPRESENTATIVES FOR FULL DETAILS . . .

Kenneth J. Asam
112 Dewitt Street
Syracuse 3, New York
Granite 4-4253

William O. Black
804 S. Kenilworth Avenue
Oak Park, Illinois
Village 8-2626

C. S. Butler
1009 First National Bank Bldg.
Cincinnati 2, Ohio

Mezey Agency, Inc.
1701 Fisher Building
Detroit, Michigan
Trinity 3-2700

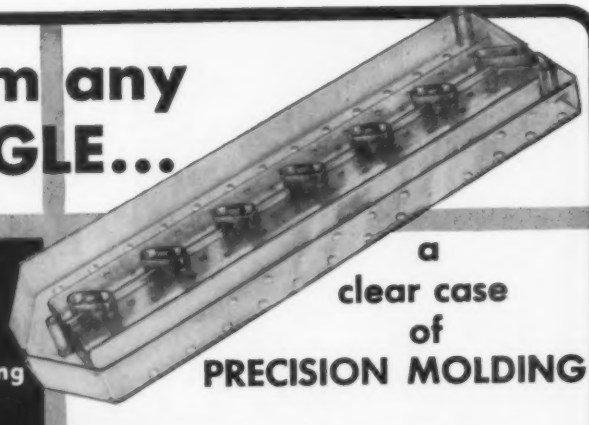
William E. Sherwood
Claremont Building
2nd and Locust
Evansville, Indiana
Harrison 2-2514

E. J. Vollhaber
1209 Arcade Street
St. Paul, Minnesota
Prospect 6-2757

E. J. Edmunds
101 N. Lexington Avenue
Havertown, Pa.
Hilltop 6-6472

CRESCENT PLASTICS, INC.
955 Diamond Avenue
Evansville, Ind., HA 5-3125

From any ANGLE...



a clear case of PRECISION MOLDING

Specializing IN THE MOLDING OF . . .
VINYLS
C-11
LOW-LOSS PHENOLICS
GLASS-ALKYD

PLASTIC PRODUCTS

Whether your problem is in injection, compression, transfer molding—or the construction of a first class mold—Albert Zollinger, Inc. offers the right solution. A complete custom molding service at competitive prices.

Albert Zollinger, Inc.
1241-49 Warren Avenue Downers Grove, Ill.

QUALITY ✓ PRICE ✓ DESIGN ✓
CAPACITY ✓ DELIVERY DATE ✓

All things check ✓
at CHARLES ZAPF & CO.

from the blue print to the finished mold, for either compression, injection or transfer molding. We are prepared to produce the best possible mold to meet your exacting requirements.

Our staff of experienced designers, engineers and mold makers, working with modern equipment, assures you of a job well done.

Our equipment includes the latest Keller and Hydrotel with capacity of molds up to four tons.

Plastic Molds
Die Cast Dies



CHARLES ZAPF & CO.
2423 MAIN STREET
EVANSTON, ILL.

greater utility for electrical work, both for reasons of superior results and for ease of handling.

The aliphatic diamines can cure a liquid epoxy resin at room temperature, or with little external heating. Aromatic-amine hardeners, though they require heat for cure, yield considerably better finished properties.

The epoxy resins have excellent adhesion to most surfaces, low shrinkage upon cure, low solvent or water absorption, good wettability, and low solvent power for insulating enamels. For these and other valid reasons the epoxy resins are being used more and more for electrical insulation.

Fillers and modifiers

Fillers are added to electrical potting and encapsulation resins for various reasons: to lower cost, to improve physicals, including toughness, to decrease coefficient of thermal expansion, to improve electrical properties, to raise thermal conductivity, to improve appearance, and to change the flow characteristics of the uncured resin.

In an encapsulation application where a nonflowing paste is required to be applied to a vertical wall, various thixotropic fillers can be used. Among these are the large-surface-area silicas, such as Santocel or Carbosil.

Toughness is improved by adding a reinforcing fiber such as chopped glass or asbestos.

To improve thermal conductivity and decrease thermal expansion, a dense filler such as tabular alumina, or fused-quartz powder is useful.

Arc resistance is considerably improved by adding electrical grades of classified mica powder.

The general criteria for selecting filler materials are: they must not react with the resin, must not contain water that is readily released, and must not evolve gas under the processing conditions.

Strain-sensitive components such as toroidal coils, accelerometers, magnetic-amplifier reactors, and similar devices that are adversely affected by the mechanical compression caused by the shrinkage of a potting or encapsulation resin around them, have to be protected. The prob-

lem is to prevent asymmetrical pressures from altering the electrical characteristics of the components. If the pressures were everywhere equal, like those applied in a hydraulic system, the characteristics would seldom be affected.

One solution is to surround the device with a layer of silicone putty (for high-temperature work), or a vinyl plastigel (for ordinary applications). Another method is to wrap the core with a closed-cell, foamed-resin tape that will act as a cushion. A variation of this is to dip-coat or paint the component with a silicone or isocyanate flexible foaming resin, and allow it to foam before proceeding.

Another technique is to add flexibilizers to the resin, so that better equalization of curing stresses occurs. Thiokol rubber, polyamide curing agents, plasticizers, and other flexibilizing resin modifiers have been used.

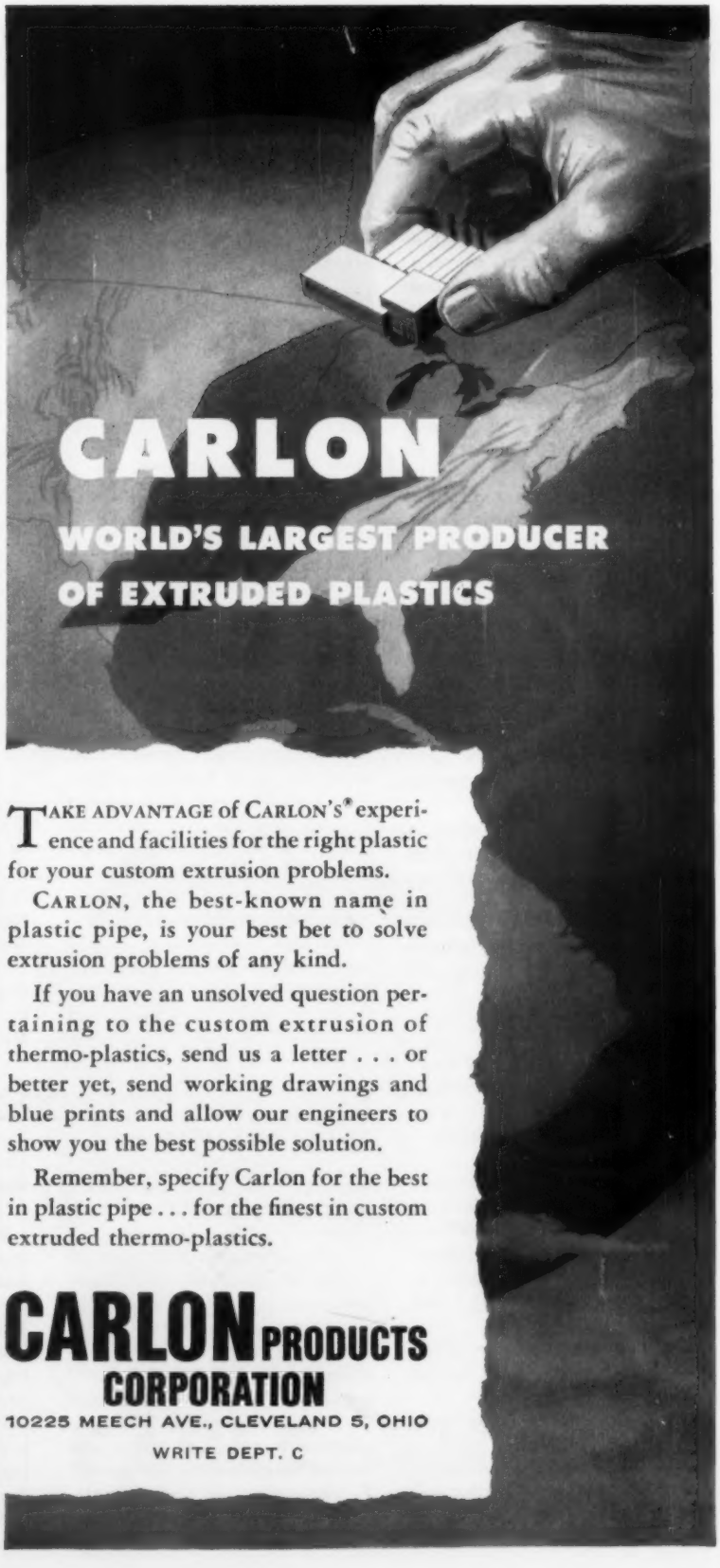
Molds

One of the big problems in electrical potting arises from the excellent adhesive quality of the epoxies. Highly desirable in getting a solid potting job, their adhesion makes it hard to get the potted assembly free of the mold. A second problem, from the production viewpoint, is the long curing period required for development of adequate mechanical strength.

Because the epoxy potting resins are liquids, the potting must be done in molds. These molds must be pretreated with mold release agents to permit separation of the component. With a cure cycle of several hours, a large number of reusable molds would be required to get high production rates. Applying the mold release, plus loading and unloading, would involve considerable labor expense. This can result in large tooling and labor costs.

There are many ways in which these costs can be lowered. The first and best is to provide a cheap, permanent "can" or cast of metal, molded plastic, or other material for the component, that remains a part of the finished unit.

If this is undesirable, a low-



cost, waxed-paper case can be used that is stripped off after the resin has set. In cases where complex re-entrant shapes are involved, such as motor armatures and field coils, a simple vinyl mold can be made by dipping a model into a plastisol. Such molds are discarded after a few runs.

For potting objects requiring a complex, self-supporting shape, a wax, soap, or other easily worked and removable substance can be made into a prototype having the desired finished dimension. A low-melting alloy such as Cerromatrix is then sprayed onto the prototype to form a shell, and the even lower-melting wax is melted out. The component is then inserted and potted; after curing, the temperature is raised and the alloy is melted and recovered for re-use.

Mold release agents

The best surfaces for release of epoxy and polyester resins are Teflon, silicones, certain waxes and greases, and plasticized vinyl or synthetic rubber, in that order. The material selected should have adhesion to the mold, and yet no adhesion to the resin.

Silicone grease, for instance, is commonly and successfully used as an epoxy resin separation agent. However, it adheres to isocyanate resins. The diisocyanates used to make polyurethane resins are so active that they will react with almost any functional groups, even those of the silicone resins and oils. In such cases, paraffin wax, which has no functional groups at all, will give clean separations.

Techniques

The best and cheapest method of potting a component is to heat it in the prepared mold to a temperature above 220° F. to drive out moisture, allow it to cool to some lower temperature, and pour in the liquid resin.

The cure cycle should set up the resin in no less than 1 hr., and be followed by a postcure.

In cases where dense structures have to be penetrated, such as the center of fine-wire solenoids, the viscous resin may harden before it reaches the center. To speed its flow, the resin-filled mold is put into a vacuum chamber and vacuum and pressure are alternately applied until bubbling ceases.



Potted rotor for all-enclosed 100-hp. motor for acid dust service. (Photo, Epoxylite Corp.)

A special application for large-scale production requiring critical electrical and mechanical specifications in the finished part makes use of centrifugal pressure to force the resin through a fine-wire coil. The centrifuge is run hot, so that the cure can take place with the resin under pressure. This has been very successful and economical in the production of ignition coils.

For high production of components such as capacitors, resistors, transformers, and other volume items, automatic equipment can be devised. Automatic metering and mixing equipment for the resin-hardener combination is available, and plunger-type molds for automatic ejection of the finished component can be arranged on a rotary table that combines loading, filling, and curing.

There is no doubt that as labor costs increase, such automatic devices will become common, and a large number of computer and radio and television components will be so potted.

New low-cost resins with improved handling and electrical properties are gradually being made available from the petrolochemicals. This, together with automatic potting equipment, will completely change the present situation of high cost.

References

For further information on properties of resins used in potting and encapsulation, consult Subject Index under resin names. For sources of supply of resins, see the Directory Index, p. 1018.

"Potting and encapsulation," by F. G. Firth, MODERN PLASTICS 33, 125 (Apr. 1956).

"High-temperature solventless encapsulating resins," by D. W. Lewis, Electrical Manufacturing 59 (March 1957).

"Environmental test for embedded electronic units," by Harper, Electrical Manufacturing 58 (Dec. 1956).

"Casting resins insulate and protect electronic components," by H. L. Loucks, Materials & Methods, 43, 90 (Feb. 1956).

FLEXIBLE MOLDS FOR CASTING PLASTICS

BY EDWARD H. NEUWIRTH*

Inexpensive flexible molds for the casting of various plastics may be easily made with the polyvinyl chloride plastisols. The plastisol is a dispersion of polyvinyl chloride resin in a liquid plasticizer, along with such additives as stabilizers, pigments, and other modifying agents. Because the plastisol is a fluid, it is easily handled by pouring or pumping. When the plastisol is heated to the proper fluxing temperature, (250 to 380° F., depending on the formulation), the material fuses into a solid flexible mass.

Plastisols make it possible for engineers to use a relatively low-cost material in the manufacture of effective molds for castings. The vinyl plastisol molds are used when limited quantities of castings are needed and the initial expense would be too high for metal molds. Since plastisol molds are tough and flexible, the castings may be easily removed from the mold. This is of particular interest to molders of polyester and epoxy parts, since the adhesion

* Watson-Standard Co., 225 Galveston Ave., Pittsburgh, Pa.

Rererences were prepared by the editors.

which these materials have for metal prevents the use of metal molds.

The use of the plastisol mold with casting materials is simple. Liquid castings are poured into the vinyl mold, cured in place, and then stripped from the mold. In the case of phenolics, the filled plastisol mold is put into a 150 to 180° F. oven for proper curing. Polyesters cure at room temperature in 1 to 6 hours.

The plastisol mold may be used to cast such plastics as phenolics, furans, epoxies, polyesters, and melamines. Except when casting polyesters, approximately 50 castings may be made in the plastisol mold before breakdown of the vinyl occurs. In the case of polyesters containing styrene, only 10 to 20 castings may be made before deterioration of the mold takes place. A release agent applied to the plastisol mold prior to casting the polyesters aids in stripping the casting from the mold.

In making a vinyl plastisol mold, a positive model is first made from plastic, wood, metal, or plaster. The model is placed in a container and the liquid plastisol is poured into the container so that it completely covers the model. The container is then placed in an oven at the recommended temperature for the particular plastisol. Sufficient time is necessary to fuse the plastisol thoroughly, so that the mold will be tough and durable. Approximately 10 min. curing time at the specified temperature is needed for each ¼ in. of thickness of plastisol. After fusion of the plastisol has been effected, the mold is cooled to room temperature. The container and model are stripped from the plastisol mold, which is then ready for use.

Some typical examples of cast articles made in plastisol molds are terminal blocks for industrial control and power wiring, internal mounting for hearing aids, remote control switch handles for X-ray machines, relay connecting mounting blocks, and other types of special castings of semi-intricate designs.

References

"How to make flexible model molds," by Edward Ferrari, Mon-

Before you mold...in NYLON or other THERMOPLASTICS (polyethylene, styrene, etc.)

consider the 3-way services of

BYRD

LESS production time • LESS cost

Skill and experience unified in a single dependable source for the three most important phases of production—

NYLON HQ

MOLD DESIGN
MOLD MAKING
INJECTION MOLDING

Result? SAVINGS . . . in production headaches, time, money, mold maintenance, handling and shipping!

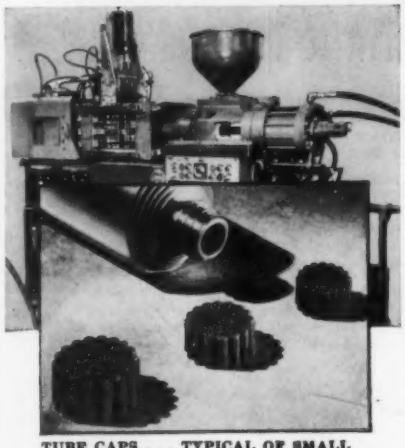
Typical examples of BYRD nylon-molded parts

2 decades of experience, 85 craftsmen, 22,000 sq. feet, [illegible] machinery, latest equipment, [illegible] company-owned aircraft . . . [illegible]SERVICE!

[illegible] for descriptive bulletin; send prints for quotation

BYRD plastics, inc. 2957 West 12th St., Erie, Pa. Phone: 3-1107

PLASTIC MOLDS
FROM THE SMALLEST TO THE LARGEST



TUBE CAPS . . . TYPICAL OF SMALL AUTOMATIC, INTRICATE MOLDS

Eagle Tool is completely equipped with machining and handling facilities for the best in mold design and construction, from the smallest, most complicated molds to the largest injection molds.

•

COMPLETE FACILITIES IN DESIGN AND CONSTRUCTION OF INJECTION COMPRESSION, TRANSFER, PLUNGER AND LOW PRESSURE MATCHED MOLD APPLICATIONS.

EAGLE TOOL AND MACHINE CO.

EVANS TERMINAL ROAD, HILLSIDE, N. J.

Telephones: ELizabeth 4-1515-16

SINCE 1918

PLASTIC INJECTION MOLDING

— ALL THERMOPLASTICS —

★ Engineering Service

★ Custom Mold Making

★ Vacuum Plating

★ Finishing

★ Assembling

QUALITY
Established 1928
SERVICE

Molded Glass - All Colors

Phone PEnsacola 6-6700

JOHNSON GLASS & PLASTIC CORP.

5254 Elston Ave. • Chicago 30, Ill.

Desert Sunshine

EXPOSURE TESTS

"We test EVERYTHING under the sun"

All products of every size and shape, are exposed to the intense solar radiation of the world's sunniest zone exactly according to our clients' instructions. Exposure periods are measured in days or months or years, in langleys, in Ultra-violet Sun Hours, or in any other unit.

Monthly inspections and reports provide a running record of the degradation of the exposed samples.

Our exposure racks now hold thousands of samples: plastic filaments, pipes, ropes, tensile bars, chairs, awnings, tail lights, plastic-coated wires, fabrics, cables, etc., etc.

There is no better place in the world to test your product than in sunny Phoenix. For the past four years, the sun has shone for 4,088 hours per year, (over 11 hours of sunshine daily for every day of the year). On racks facing south at 45°, yearly solar radiation has totalled approximately 200,000 langleys and 2,200 UV Sun Hours.

Send us your samples! Or write for quotation and our free monthly weather report and "DESERT-ation."

For the Quickest Test
Send Your Samples Southwest

DESERT SUNSHINE EXPOSURE TESTS
7740 RAMONA ROAD PHOENIX, ARIZONA

Member:
American Association of Textile Chemists and Colorists; American Society for Testing Materials; American Chemical Society; Alpha Chi Sigma; Arizona Academy of Science.

ERN PLASTICS *31*, 93 (J[illegible] 1954).

"Big elastomeric [illegible]olding," MODERN PLASTICS *31*, [illegible] (Feb. 1954).

"On stage with plasti[illegible]," MODERN PLASTICS *30*, 94 (Sept. 1952).

"Effect of temperature and composition upon the resilience of elastomers," MODERN PLASTICS *29*, 120 (Aug. 1952).

"Soft products for hard use," MODERN PLASTICS *28*, 73 (Sept. 1950).

"The use of flexible elastomer molds in casting plastics," Edward Ferrari, Technical Information Series, Appearance Design Section, Small Appliance Div., General Electric Co.

"Technical Bulletin #71," Elastomer Chemical Corp.

PLASTISOL MOLDING

BY W. J. KAUFMAN*

A plastisol is a polyvinyl chloride resin dispersed in a liquid plasticizer along with colorants, stabilizers, and other modifying agents; the resulting compound may be either a liquid or a paste in form.

The most common molding plastisols are relatively low-viscosity liquid compounds that are pourable for ease of handling. They may be poured, pumped, or sucked into a mold, or a mold may be dipped into the liquid. They are considered as 100%-solids materials; therefore, there are no solvents or diluents to be evaporated and cause shrinkage problems. The plastisol which lines, fills, or coats the mold is converted to an elastomeric compound by raising its temperature to 350 to 400° F. Once this temperature is attained by the mass, conversion or fusion is practically instantaneous.

Vinyl sponge or foam is a recent plastisol development. Various expanded or cellular plastisols produced by different methods and having a wide range of density are now commercially available. See p. 334 for further details on the subject of the foamed vinyls.

Physical properties are determined by specific formulations

*Technical Sales Dept. Watson-Standard Co., 225 Galveston Ave., Pittsburgh, Pa.
References were prepared by the editors.

and plastisols may be compounded with properties within the following ranges:

Tensile strength	1500 to 4000 p.s.i.
Elongation	350 to 500%
Hardness (Shore Durometer)	40 to 95
Color	Clear whites, pastels, dark or bright colors
Viscosities	20 to 1000 p.

The molding techniques commonly used may be designated as 1) dip molding; 2) slush molding; 3) rotational molding; and 4) low-pressure injection molding techniques.

Dip molding

Dip molding consists of dipping an external mold into the plastisol bath, fusing or fluxing, and then stripping the finished article off the mold. Automotive pump diaphragms, spark plug covers, collapsible tubes, thread protectors, boots, and toys are but a few of the items that may be made on a commercial basis by this technique. The molds are usually solid and are made of cast or machined aluminum, machined brass, steel, or ceramic.

A typical dip molding system includes a conveyorized line passing through a preheat oven, a dipping station, a fusing oven, a cooling station, and a stripping station. The preheat oven is used to heat the mold prior to dipping. Although, in certain cases, the molds are dipped at room temperature, normally the molds are preheated to control the thickness of the plastisol deposited on the mold. For most common applications (wall thickness of 1/16 to 3/32 in.), the mold is heated to approximately 300° F. prior to dipping. For heavier wall thickness the preheat temperature should be higher. The mold is inserted into this plastisol bath rapidly and then withdrawn at a rate of from 4 to 6 in. per minute. In some cases, the mold is inverted, after withdrawal, to allow for redistribution of excess liquid plastisol. The plastisol on the mold is then fused at oven temperatures from 350 to 400° F. The length of time in the oven will vary from 5 to 15 minutes. After fusing, the mold is cooled (either

PLASTICRAFTERS INC.

CUSTOM MOLDERS OF INJECTION, COMPRESSION, TRANSFER MOLDINGS AND REINFORCED PLASTIC PRODUCTS OF ALL TYPES

Our moldings are always of excellent quality. We design them with care, mold them to precise standards, and deliver them on the date promised. We offer this service to you at reasonable, competitive prices. One of our representatives will be glad to give you complete additional information.

PLASTICRAFTERS INC.
1829 South 55th Ave.
Cicero, Illinois



Injection Molding - Mold Making

new HIGH SPEED equipment

PRESS CAPACITY TO 20 OZ.

COMPLETE TOOL ROOM FACILITIES.

PARAGON MOLDING CO.

2412 Norwood St. Melrose Park, Illinois

Filmore 5-1717

RECTO

Injection • Compression • Transfer Molding of PLASTICS Since 1920

Plastic products are developed from idea to completed product by RECTO

•

MOLDS MADE IN OUR OWN PLANT

RECTO MOLDED PRODUCTS, INC.

Custom Molders of Plastics Since 1920

CINCINNATI 9, OHIO Phone: MElrose 1-6802

air cooled or water sprayed) and the molded piece is stripped from the mold.

Combinations of expanded vinyls and plastisol skin may be adapted to this method of molding, which is of particular interest in the manufacture of such items as boots and gloves because of the insulating qualities of expanded vinyls.

The vinyl skin is formed as outlined above. After the plastisol on the mold surface is cured, the mold is inserted into the plastisol sponge (chemically blown type) bath and then withdrawn. After that the mold is usually inverted to allow redistribution of the sponge plastisol and then fused at temperatures of 350 to 400° F.

Thickness of the sponge section may be controlled by two methods: 1) heat of the mold and 2) rate of expansion of the sponge plastisol compound.

Since mold detail is on the interior of the dip molded piece, the part is sometimes turned inside out, as in the case of dip molded boots. This is usually true also of plastisol-sponge combinations since the insulation is required on the interior of the molded part.

Dip molding lends itself to high rates of production since many individual molds may be dipped at one time. This method also lends itself to practically automatic molding since the molded parts may be automatically removed or stripped from the molds by compressed air, so that a single operator may run a complete production line.

Slush molding

Basically, slush molding is a process whereby a liquid is poured into a hollow mold, then withdrawn or dumped, leaving only a lining of material on the interior of the mold. The molds used in this process are usually electroformed copper molds, or fine aluminum sand-cast molds. Heat is applied to convert the plastisol to an elastomeric compound, and then the mold is cooled to a temperature for convenient handling to strip the molded piece.

Most of the production lines us-



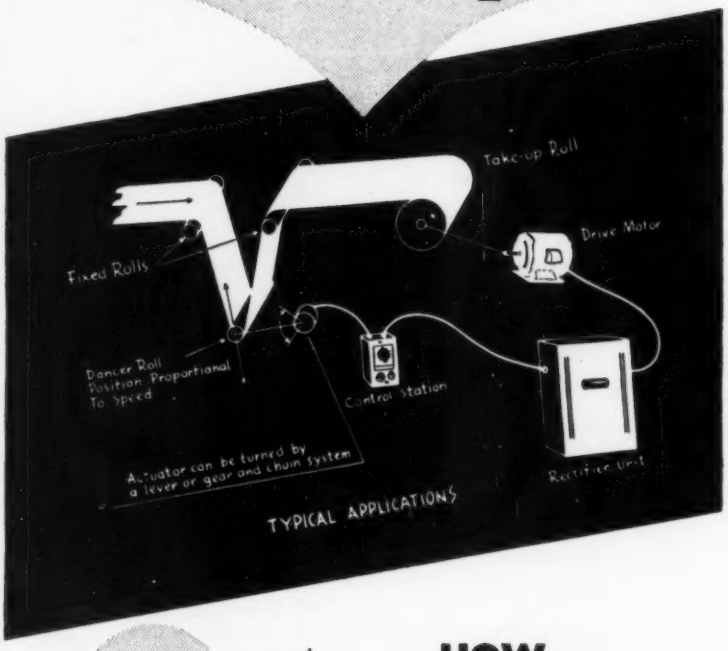
For the ultimate in realism, vinyl plastisol can be molded into natural foliage forms. (Photo, Marlo Studios)

ing slush molding follow one of two basic systems—the single-pour system and the double-pour system. Both of these are readily adapted to conveyorized lines.

A single-pour system involves a single filling station where the molds are filled by the vacuum, gravity, or pressure method. If gravity or pressure filling is used, the filled molds are either spun or vibrated to eliminate bubbles at the extremities. Then the molds are heated—usually by infra-red or by immersing in hot water—to adjust or control wall thickness. Heating at this point in the system is necessary so that the plastisol in immediate contact with the walls of the mold is gelled; the mold is then inverted and the plastisol allowed to drain out. The plastisol lining left in the mold is then fused in an oven at temperatures from 350 to 375° F. The fusing time depends on the size of the molded piece and the wall thickness desired in the finished part. Following the fusing cycle, the mold is cooled, usually by fine water spray.

The two-pour method is a modification of the above. Here again the mold is filled almost to the top, usually by gravity or by pumping, and the mold is vibrated to remove bubbles from extremities. It is then dumped, leaving a thin film of plastisol on the surface. By filling a cold mold in this

Servospeed
Automatic
Take-Up



HERE'S HOW IT WORKS
...for Textile and Plastics Processing

A small tension change positions the actuator shaft so as to call for motor speed change to restore preset tension. Thus a constant linear feet per minute windup may be achieved even though the radius of takeup roll increases with each turn to otherwise increase linear speed versus radius build-up. Speed is now made proportional to position of dancer roll and tension is held essentially constant, as is the linear rate of material travel.

These and other models of electronic motor speed control systems available from 1/50th to 2 horsepower.

WRITE

Servospeed
4 Godwin Ave. Paterson, N. J.

BETTER . . . *by Design!*

VOGT Vinyl EXTRUSIONS

Custom Service . . . Fast Delivery

It's no accident that Vogt vinyl extrusions are *better* . . . they're *designed* to be! And Vogt custom service is *complete*—from the first analysis of your needs to the prompt delivery in volume of the precision-made product. Here are six reasons why Vogt extrusions will save you money:

6 Points of Superiority

1. **DESIGN** Vogt engineers will carefully design the extrusion best suited to your job.
2. **COMPOUND DEVELOPMENT** Our plastic laboratory will develop a compound to meet your most exacting requirements.
3. **COLOR MATCHING** Our color matching experts will quickly match any color or shade with the greatest accuracy.
4. **DIE CONSTRUCTION** Without delay, our die shop will construct a perfect die.
5. **SAMPLES** Our sample department will rush a sample to completion for your approval.
6. **FAST, QUALITY PRODUCTION** Our production department will make volume deliveries of uniformly high quality extrusions in record time.

Vogt's facilities include a modern research department, a complete experimental department, and experienced production and quality control departments. Thus you can be sure that the latest and most efficient materials and processes will be employed; that samples will meet your needs for color, finish, hardness, heat and light stability, volatility, flexibility, toxicity and migration; that accurate compounding, production, testing and checking will result in final extrusions that meet specifications exactly.

Whether you require tubings, rods, bindings, weltings, or special shapes, it will pay you to consult Vogt.

THIS 75-YEAR OLD FIRM SERVES THESE INDUSTRIES:
Transportation • Refrigeration • Toys • Building
Agriculture • Chemical • Furniture

VOGT MANUFACTURING CORP.
100 Fernwood Ave., Rochester 21, N. Y.
Detroit Sales Office: 630 Lycaste Ave.

MAKERS OF VOPLEX PRODUCTS

manner there is less chance of entrapping air or of gelation over fine details at the extremities.

After dumping and draining, the mold is passed through an oven to fuse or semi-fuse the first skin. Here the oven may be either a hot-air type or an infra-red type. After passing through the first pour oven, the mold is then filled a second time, dumped, and allowed to drain. The length of time the mold is in the first oven determines the wall thickness of the final part because the heat of the mold retained from the setting or fusing of the first skin will determine the ultimate thickness of plastisol deposited on the walls of the mold. The mold is then passed through a second oven where final fusing of the plastisol part is obtained. The mold is then cooled and stripped in the same manner as in the single-pour system.

Sponge plastisol may be handled similarly when items such as boot socks and toys are manufactured completely of sponge. When a plastisol skin-sponge combination is desired, a two-pour system is used. A sponge vinyl plastisol is poured in the second position. This method is used in the production of dolls and doll parts, insulated boots, and electrical component covers.

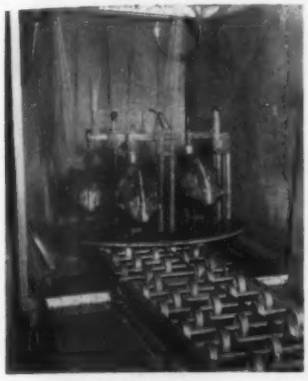
To point out advantages of the different processes is difficult since they are very similar in nature and the final products in both methods are accepted commercially. However, it is obvious that handling in the single-pour method is at a minimum, whereas in the two-pour method the possibility of air entrapment is reduced to a minimum.

Slush molding has many advantages in the production of open hollow moldings. The process is relatively simple. Parts which show no parting line may be made in a single-piece mold. When the piece is removed from the mold t is finished and, except for decorating, there is no finishing expense. Undercuts present no problem whatsoever, as they do in other conventional types of molding. Fine detail is easily obtained.

This method of molding has



Plastisol-filled molds, mounted on metal plate are first placed in an oven for cure



Metal plate with molds then passes under streams of cold water, before removal of end-product. (Photos, McBell)

found wide usage in the doll and toy industries. Some other products made by this process are boots, finger cots, novelties, collapsible tubes, and mannequins.

Rotational molding

Rotational molding of plastisols is a modification of the slush molding technique. Rotational molding refers to the manufacture of completely enclosed hollow moldings in two-piece molds. A predetermined amount of plastisol is introduced into one half of the mold; the two mold parts are clamped together and then rotated in two planes. This rotation is accompanied by heating either to gel or to fuse the film of plastisol after it has been evenly distributed on the interior walls of the mold.

Rotational molding is rapidly replacing slush molding processes. There are several advan-



The hob (1) a replica in hard tool steel of the finished piece, is pressed into steel blanks to produce hobbed cavities (2) which are then machined (3) for insertion into a die shoe or mold frame.

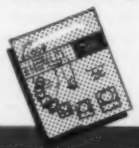
CUT TOOL COSTS WITH

NEWARK DIE HOBBED CAVITIES

Die hobbing is often the key to lower tool costs. This process produces steel cavities with a minimum of machining, filing and polishing operations . . . and adds the insurance of maximum uniformity in multiple cavity molds or dies.

What's more, as the steel alternately flows and condenses under the hobbing pressure, the mold takes a closer surface grain structure that more faithfully reproduces detail in the finished product.

NEW! *Now Producing cast cavities by the Shaw Process*



Write for your free copy of "How and When to Hob." Or let us discuss directly how Newark's complete die hobbing facilities and experience with all sizes and types of cavities may benefit you. No obligation, of course.

NEWARK DIE HOBBING AND CASTING CO.

30 SCOTT STREET, NEWARK 2, N. J. PHONE MArket 2-3305

NYLON

Custom

INJECTION MOLDING & FABRICATING

- ENGINEERING
- DESIGN
- MOLDING
- PRODUCTION
- SECONDARY OPERATIONS

LOWER COST TOOLING

WITH OUR

"STOCK MOLD SYSTEM"

Free Catalog Sheet On Request

SOCIETY OF THE PLASTICS INDUSTRY · SPI

KEOLYN PLASTICS

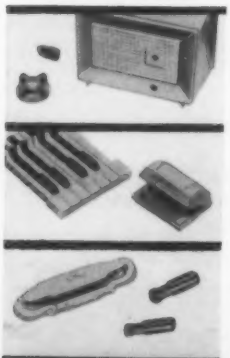
Molders Since 1936

2729 N. PULASKI RD. CHICAGO 39, ILL.

Lor-El's



TECHNIQUE OF understanding PLASTICS



The plastic field is young and new and so are we of Lor-El; young, new and aware of a continuing surge of new types of plastics and of advances in techniques and technology.

Lor-El's technique is "understanding the plastics"—Each resin has its own limitations, its own advantages, toughness—pliability—hardness—coloring—flexibility and then cost. Lor-El engineers will help you select the combination of advantages that will drive your product to the fore in a competitive market for they are technologically up to date.

. . . And then you may rest assured—for at Lor-El machines and equipment are available to meet exact production schedules.

Then why not try us today? A telephone call will do.

Lor-El COMPANY

225 PATERSON PLANK ROAD

Oldfield 3-4066

JERSEY CITY 7, NEW JERSEY

Member of S.P.I.

tages to rotational molding, namely: weight of molded parts may be accurately controlled; there is less possibility of contamination of the plastisol; the reject rate is lower; there is less scrap; and the operation is much cleaner.

Rotational molding equipment is generally classified as continuous type or batch type. Molds used for rotational molding are both electro-formed copper and cast aluminum; in some cases, machined aluminum molds are used. Depending on the surface desired on the finished product, the molding surfaces of these molds are left as they are cast or polished to a high finish. The highly finished molds produce a glossy surface on the finished product, while unpolished surfaces leave a dull or mat finish. The parting line of the molds should be machined after casting so that the mold will close tightly, preventing leakage while the plastisol is in the liquid form and thus reducing objectionable flash on the molded part.

The simplest type of rotation equipment is the batch type. Basically it consists of a platform which rotates in two dimensions simultaneously and is normally enclosed in an oven for heating the molds while they rotate. The molds are filled outside the oven and clamped on a plate. The plate to which molds are fastened is then locked in place on the rotating platform. In most cases the plastisol is fused while in the rotator; however, in some cases, the plastisol is merely gelled or set in this equipment and then removed and fused in a separate fusing oven. The advantage of fusing in a separate oven is a large turnover of molds in the rotator.

The continuous type of rotational molding equipment consists of a conveyorized system with individual rotational stations. These rotational stations travel on the conveyor. A complete cycle includes automatic volumetric filling of the molds, automatic closing, engagement of rotational gearing, fusion of the plastisol while rotating, cooling of the mold either by water spray or cooled air, automatic opening of the



Molded plastisol one-piece housing for battery tester eliminates shortcomings of metal model at no extra cost

mold, and removal of the finished part. This equipment is highly mechanized and necessarily complicated. It is operated with a minimum of labor and is capable of achieving a high production rate.

In the rotational equipment described, the rotation in each axis or plane is regular or circular in nature. By the use of irregular motion in each plane, one equipment manufacturer claims that a more even distribution of plastisol in irregular molds may be obtained.

Moreover, it is still further claimed that, by the use of cams, localized deposition may be accurately accomplished. Thus, in the case of a hydrometer bulb or a toilet tank ball valve, one section of the molded part could be of a heavy wall thickness while another portion could be much thinner.

Typical molded plastisol parts made by the rotational method are toys and doll parts, display items, balls, toilet balls, and the like.

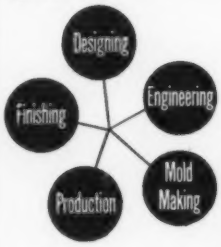
Low-pressure injection molding

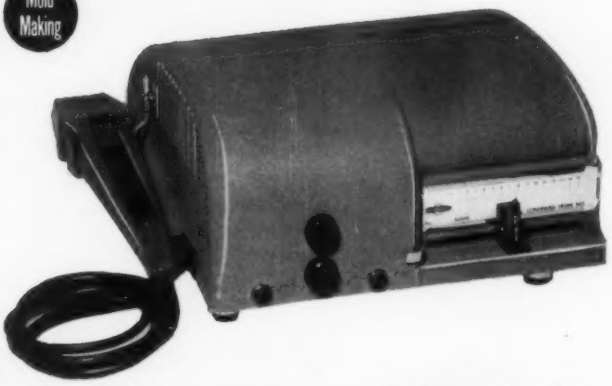
Plastisols are used in the manufacture of solid castings or solid molded parts although not as extensively as in the manufacture of hollow molded parts. The simplest process for the manufacture of solid molded parts is merely pumping or pouring plastisol into a cavity until it is filled. Usually it is necessary to use a

Building a successful product starts with

Custom Injection, Compression & Hand Molding

by Industrial





Are you a stickler for precision and quality? Then follow the lead of Peirce Dictation Systems Corp., Chicago, Illinois. Their entire operation hinges on the magnetic belt recording mechanism contained in the phenolic housing shown above. That's why they are particular about its appearance and performance. That's why they chose Industrial Molded Products to mold it.

When you call on Industrial, your compression or injection molding job is in the hands of an organization experienced in this type of work since 1934. Every operation, from mold design and manufacture to finishing and assembly, is coordinated carefully to bring you the high-quality molded parts you want, when you want them.



Multiple drilling units, such as this one shown tapping holes in a switch box, save time and cut costs for Industrial's customers. Modern mechanized assembly and finishing methods are used wherever possible. Rigid quality controls maintain established standards.

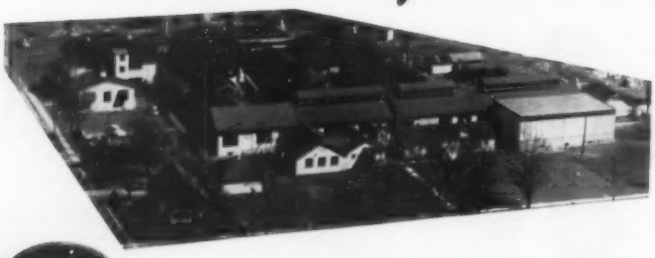


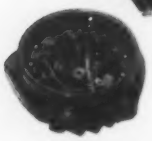
High-speed compression presses are at work 'round the clock meeting customer requirements. Industrial uses a battery of hand presses for short production or experimental runs on parts for which building expensive automatic molds is not warranted.

Write us about your molding requirements and problems . . . for fast, economical, completely satisfactory results. Industrial is known for service.

Industrial Molded Products Co., Inc.
P.O. Box 644 Palatine, Illinois Chicago Phone: ROdney 3-5700

DIEMOLDING SPECIALIZATION BENEFITS *You!*









If you have a thermosetting plastics problem, we'd like a chance to solve it for you. Our complete, modern plant is set up exclusively for compression, transfer and plunger type molding, and our experience dates back to 1920.

An ideal Central New York location permits overnight deliveries to all major industrial centers of the East. Our technical "know-how" and equipment are at your service. . . . Write today for the Diemolding story.

Specialists in molded cooking utensil components and electrical insulation parts.

DIEMOLDING CORPORATION

CANASTOTA, NEW YORK

Duplicator • Pantograph • Rotary Head Miller • Day and Night Operation • Complete Tool Room • Heat Treat • Lathes

PLASTIC MOLDS

• *The Largest or The Smallest in*

INJECTION – COMPRESSION – TRANSFER –

• DESIGNERS and BUILDERS •

Our new Plant fully equipped with modern Machinery and backed by years of Experience in Designing and Building of Molds is at your service.

CHICAGO MOLD ENGINEERING CO.
INCORPORATED
4141 WASHINGTON BLVD., HILLSIDE, ILL.

Telephone:
Linden 4-2852

covered cavity mold for this process because during the heating or fusing cycle there is some expansion of the plastisol followed by some contraction on cooling. On parts where thick cross-sections are molded, bleeders are necessary to relieve or reduce the pressure on expansion. The time necessary to fuse any given molded part by this method will depend largely on the cross-sectional thickness of the part. A rule of thumb to determine approximate fusing time is that, for every ⅛ in. of cross-section, 7 min. of curing time should be allowed at 350 to 375° F. Molded parts with cross-sectional thickness as high as two inches have already been made and marketed.

A more advanced technique for this type of molding might be designated as low-pressure injection molding. The equipment necessary for this type of injection molding is simple since the plastisol is liquid. Low-pressure pumps of the grease-gun variety can be successfully used to inject the liquid plastisol into a two-piece mold or cavity. Here the molds must be designed with bleeders at the cavity extremities to allow for complete filling. The process is simply to close the mold, pump the plastisol into the mold until the excess emits from the bleeders, place the mold in an oven for fusion, remove, cool, open the mold, and take out the finished part.

The molds used for this method are of aluminum, copper, brass, or steel, and they are either sand cast or machined. As in the rotational molds, the closing surfaces of the two-piece molds must be machined to provide a tight fit and, again, the finish of the molded part depends entirely upon the density, polish, or texture of the mold surface itself. The wall thickness of the metal molds should be kept to a minimum to provide for quick heat transmission but thick enough for good structural strength to withstand the pressures involved.

For the most part, solid plastisol moldings are made by the batch process. Conveyorized continuous molding processes are not practical, due usually to the length of time required for fusing

the solid plastisol parts. The batch process is excellent when a limited number of parts are required since the mold cost in comparison with that for conventional injection molds is very small.

Some applications of plastisol parts made by the batch process are seals for ceramic tile, sink and disposal stoppers, advertising display plaques, and novelties.

Combined methods

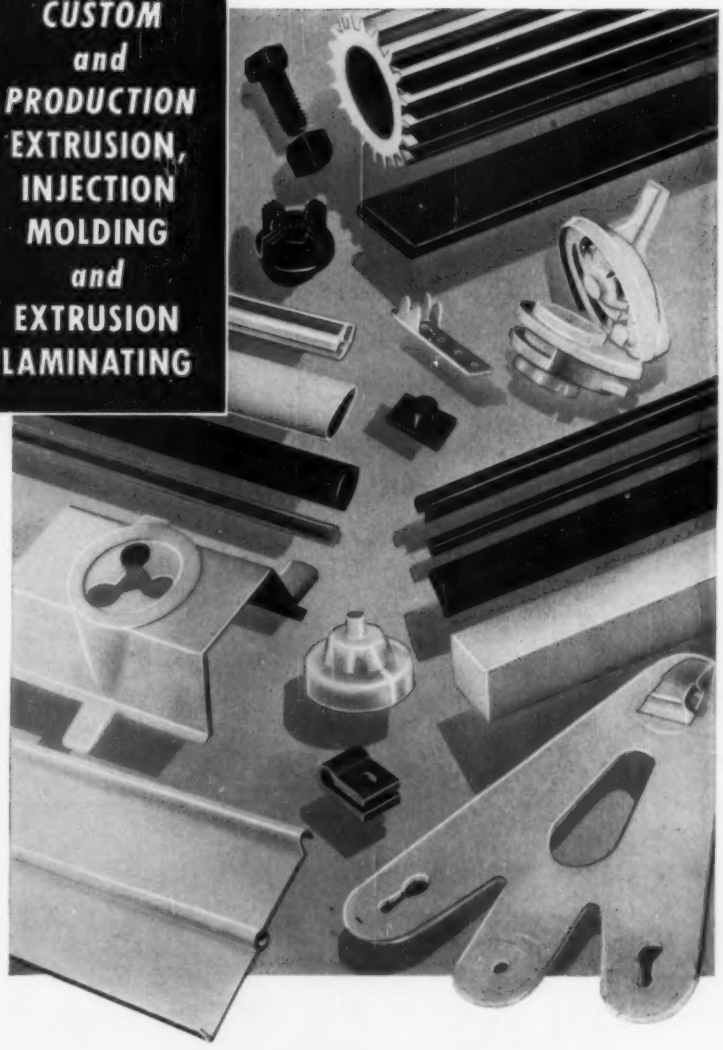
There are occasions, particu- parts made by the batch process vinyl combinations, when the use of two of the above-mentioned methods is advantageous to produce a single product. Items (such as arm rests, gaskets, toys, squeeze balls, and electrical packings) having a tough outer skin of vinyl plastisol and a solid interior of expanded vinyl, may be produced by spraying, slush molding, or rotational molding of the skin, and by casting, low-pressure injection, or rotational molding of the interior.

Combination plastisol skin and expanded vinyl products may be divided into two categories: 1) Those in which the complete exterior surface is a plastisol skin, as in the case of arm rests, crash pads, toy blocks, squeeze balls, toys, and others. 2) Those in which only part of the surface is a plastisol skin, such as gaskets, packing, chair seats, and others.

For products requiring an exterior surface completely covered with plastisol skin, a combination of rotational molding and low-pressure injection molding may be used. In this case the skin is molded in the normal rotational method. After curing of the skin, but while the mold is still closed, vinyl sponge or foam is injected into the interior of the mold. In the case of vinyl sponge the amount injected is predetermined, but with vinyl foam the mold is filled. Then the mold is either placed back in the rotational equipment or into a conventional oven for fusing or expanding the sponge or foam plastisol.

For products having a plastisol skin on only a portion of the exterior surface, several methods may be used. The vinyl plastisol may be sprayed on the surface

CUSTOM and PRODUCTION EXTRUSION, INJECTION MOLDING and EXTRUSION LAMINATING



CUSTOM PROFILE EXTRUSION
CUSTOM INJECTION MOLDING
CUSTOM EXTRUSION MOLDING

Extruded Rods, Tubes, Sheets & Film in most Thermoplastics including Nylon

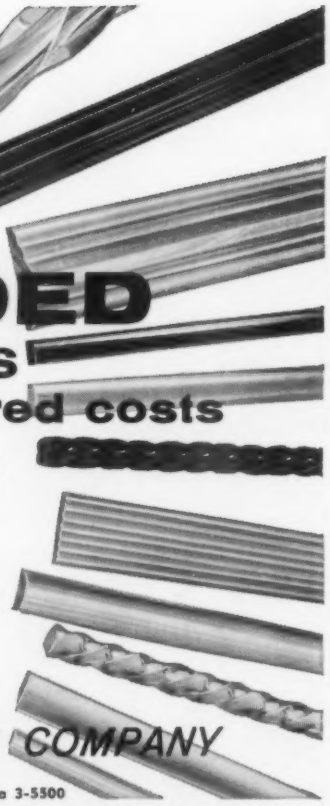
Heavy Gauge Thermoplastic Sheets For Vacuum and Pressure Forming

H&R INDUSTRIES
NAZARETH, PENNSYLVANIA

WE BORROW FROM TOMORROW . . .
TO IMPROVE TODAY

NOW!
ACE
helps you get
EXTRUDED
PLASTIC PARTS
faster... at lowered costs

New e-x-p-a-n-d-e-d production facilities now make it possible for you to reap the benefits of Ace's *exacting* mass production . . . close tolerances . . . low, low costs . . . on a wide variety of
RODS • TUBES • SHAPES
in *all* colors . . . in your choice of
PLEXIGLAS • LUCITE • ETHYL CELLULOSE
POLYETHYLENE • ACETATE • BUTYRATE
in stock . . . or quickly made to your specifications.
Write, wire, phone for bulletin, samples and prices . . . or send specifications, blueprints, for immediate quotation.



Ace PLASTIC COMPANY
Extrusion Molders and Fabricators
91-62 Van Wyck Expressway, Jamaica 35, N.Y. JAmaica 3-5300

4 reasons why it pays to specify
BUSADA BUTYRATE
Transparent PLASTICS TUBING

1. Transparent—colorless
2. Consistently high quality
3. Close tolerances
4. Size for every need . . . ¾" to 6" O.D. 6 ft. and 20 ft. Lengths

Send us your specifications. We'll make the tubing to fit the job

Industry uses our complete line of BUSADA BUTYRATE PLASTICS PIPE and FITTINGS

BUSADA MANUFACTURING CORP.
58-99 54TH ST., MASPETH, LONG ISLAND, NEW YORK
EVergreen 6-0202

of the mold either with or without masks and then set or fused. The vinyl sponge or foam is then cast into the mold and fused. The skin plastisol may also be slushed into the mold and cured, and then the vinyl sponge or foam cast and fused.

Molds and equipment used in the manufacture of combination vinyl plastisol-expanded vinyl products are of the same general type as those used for conventional plastisol products.

The above-outlined methods are general; no two molders use the same processes or even the same equipment. Each molder has his individual ideas as to fusing time, fusing temperatures, methods of removing or eliminating bubbles, preheating of molds after fusing, etc. The suitability of the plastisol to the method and type of mold used should be determined by the individual molder, based on his own experience gained by solving similar problems in the past.

References

For further information on vinyl materials, see p. 164. Also consult the Subject Index and the Directory Index.

"Durable decoys for ducks," MODERN PLASTICS *33*, 110 (April 1956).

"Rotational molding of plastisols," MODERN PLASTICS *33*, 123 (Sept. 1955).

"Have you looked at vinyl dispersions lately?" MODERN PLASTICS *33*, 106 (Nov. 1955).

"More bounce in vinyl balls," MODERN PLASTICS *32*, 96 (Sept. 1954).

"Slush molding molds and techniques," MODERN PLASTICS *30*, 97 (July 1953).

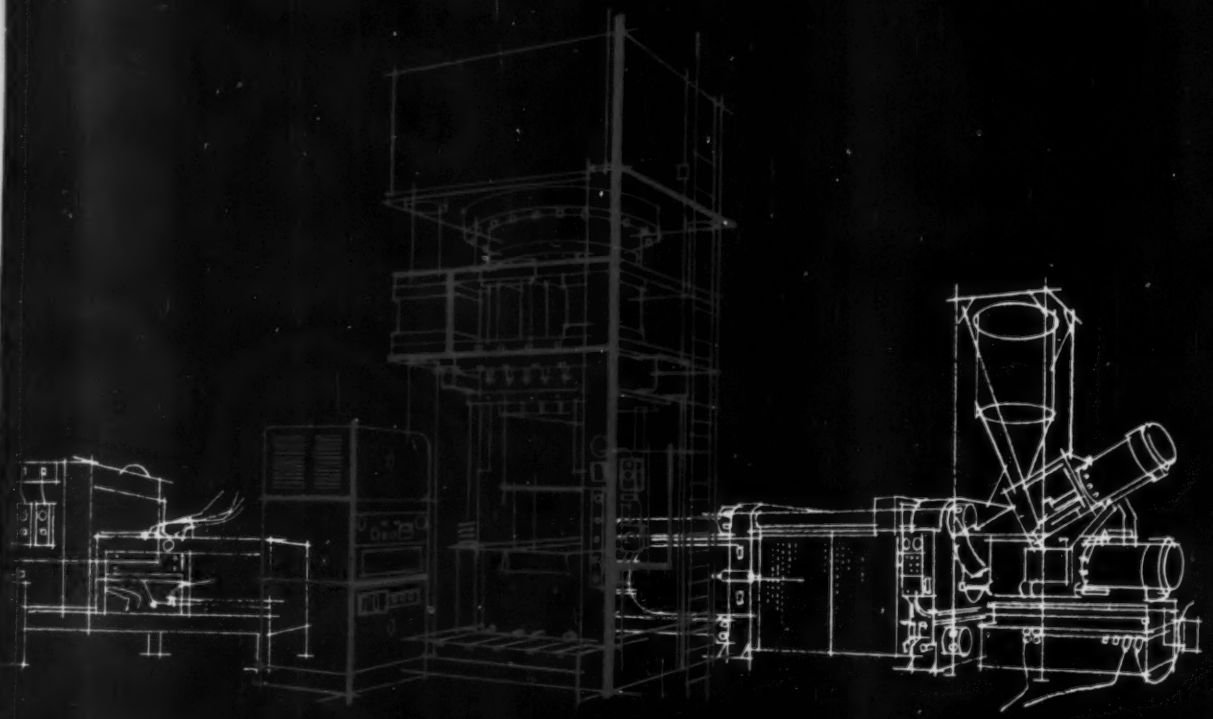
"Getting the best from plastisols," MODERN PLASTICS *30*, 116 (Nov. 1952).

"Rotational casting of plastisols," MODERN PLASTICS *29*, 109 (May 1952).

"Vinyl dispersions," S.P.I. Handbook, Reinhold Publishing Corp., Chap. X, 247 (1954).

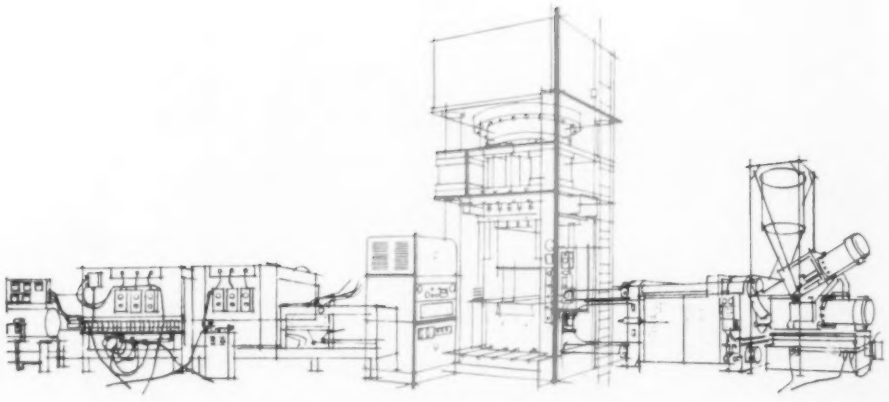
"How plastisols are prepared and their uses in toy molding." Playthings *51*, 182 (May 1953).

"Vinyl plastisols and plastigels," by P. O'Keefe, Materials & Methods *37*, 104 (Sept. 1952).



this is
America's leading
custom molder of plastics . . .

GENERAL AMERICAN



General American's capacity, versatility, service

assure the right process for your job

In plastics, you'll find General American ready to meet your every requirement. General American's *physical size* permits the setting up of special conveyors, finishing lines and equipment in their most efficient form. General American's *versatility* offers you the proper process and the correct material for your job. General American's *service* brings you experienced help with your problem. General American's research assures you of *continuing leadership* in new materials, improved techniques and product development. Because you get all these benefits from a single source, you'll find *it pays to plan with General American.*

consult General American . . .

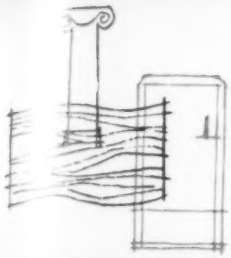
Plastics Division engineers consult with you to recommend the best method and material for producing your job. Since General American specializes in all the major molding processes you are assured of getting the correct, most economical method for your product.

to meet your every production requirement, General American offers:

31 Compression and reinforced plastics presses ranging from 100 to 200 ton.

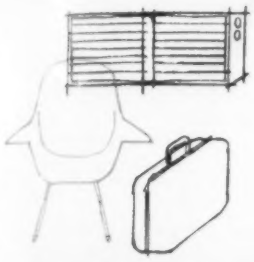
57 Injection molding presses ranging from 2 oz. to 300 oz.

7 Extruders with fully automatic in-line vacuum forming equipment



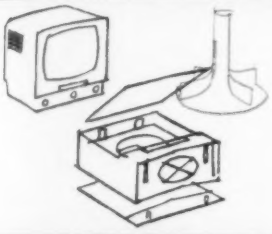
gen®

Gen, a completely new idea in decorative plastic sheeting created by General American, is an exclusive process whereby an exact photographic reproduction of any pattern, material or design can be applied on modified styrene sheeting. Simulated wood, marble, leather, etc., are easily obtained. Gen can be formed for durable, lightweight display pieces for example, or deep-drawn for refrigerator doors, automobile interiors and similar decorative applications. Gen is available in any length or width up to 40" or vacuum formed to your specifications.



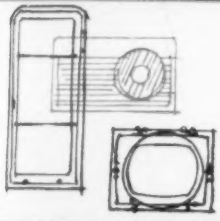
pre-mix

Where higher service temperatures and low cost are required, General American Pre-Mix may provide the answer. This is an extremely versatile molding compound consisting of the resin best suited to your application and chopped fibers such as glass, sisal, nylon or other material. Easily formed by compression, Pre-Mix requires no preformed mat and is an excellent material for plastic products or components such as radio and TV cabinets, furniture, air conditioners, carrying cases and luggage, electrical applications and automobile heating ducts or glove compartments.



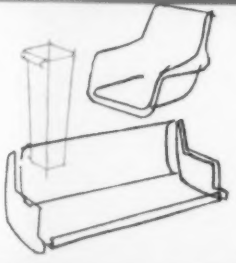
compression molding

Your product or part may require molding by compression for thermosetting plastics (melamine, urea, phenolic resins, etc.). Television and radio cabinets, electrical components and appliance parts and agitators for washing machines are some examples of the large and complex parts molded in one-shot on General American's huge compression presses.



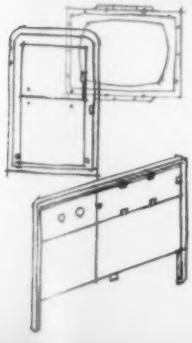
injection molding

Injection molding of thermoplastics (the acrylics, polystyrenes, vinyls, fluorocarbons, nylon, etc.) might prove to be the best process for your part. Batteries of injection presses at General American have molded air-conditioner fronts, large refrigerator inner-door panels and breaker strips, circular fan housings and electrical appliance parts for the country's leading manufacturers.



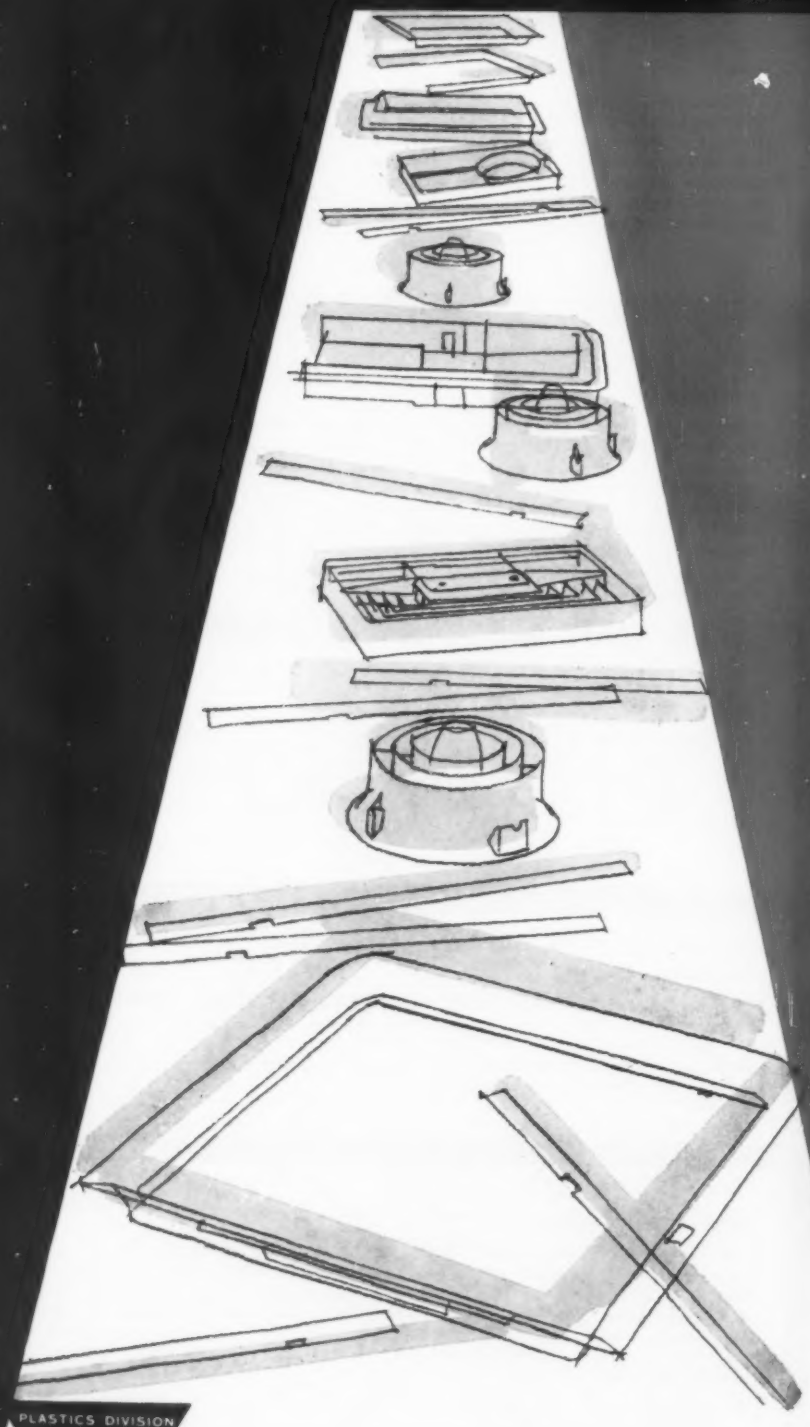
reinforced plastics

General American pioneered in the techniques of molding reinforced plastics. Using an additional substance for strength (such as glass fibers), reinforced plastics have earned recognition and acceptance because parts can be molded with great strength and light weight in large size (up to 16 feet in length on General American's new press). Sofa frames, chairs, cases, tubs, outdoor sign trims (molded in sections up to 12 feet) and office equipment housings are examples of what General American has done in reinforced plastics.



extrusion and vacuum forming

Continuous vacuum forming of extruded thermoplastic sheet has grown into an important segment of General American's plastics operation. Specially-engineered equipment for vacuum forming of high-impact polystyrene and other thermoplastics was built in the General American plant. Refrigerator panels, television-cabinet and air conditioner fronts and housings for lighting fixtures can now be produced by vacuum forming at a faster rate with advantages of ease and speed of tooling, lower cost tooling and flexibility in changing designs. Pipe for a leading manufacturer is an example of General American's custom extrusion.



it pays to plan with General American

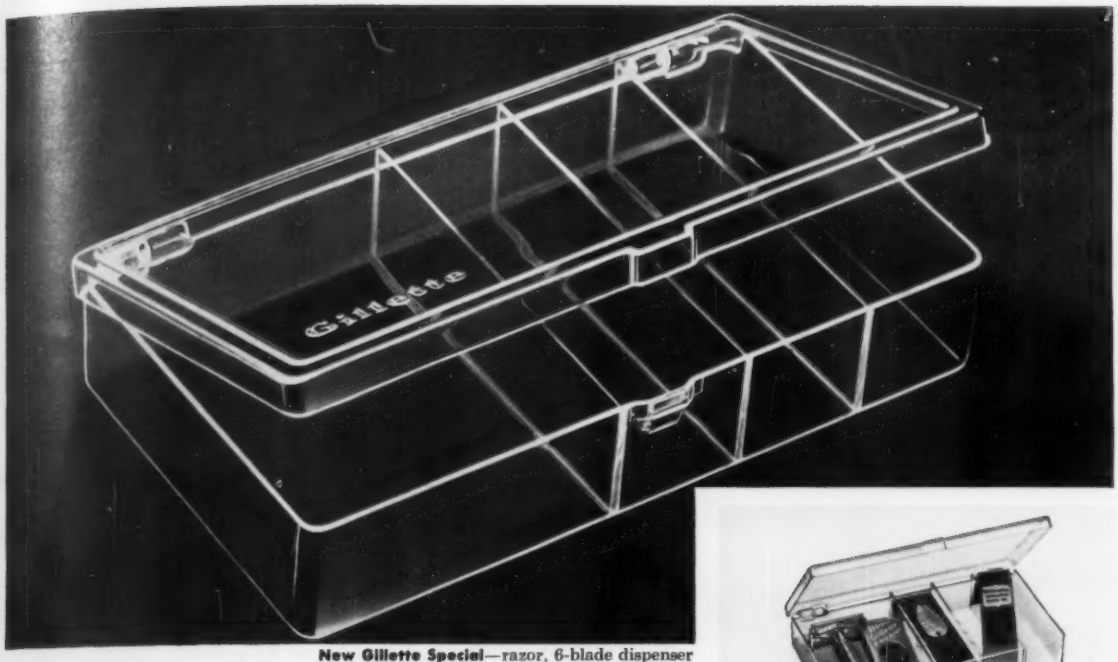
If you are designing a new product or considering changes in a product you now manufacture, you'll find it pays to plan your products in plastics—molded by General American.

We invite you to visit our plants and laboratory at East Chicago and see the General American Plastics story in action.

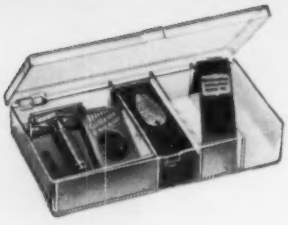
PLASTICS DIVISION
GENERAL AMERICAN
TRADE MARK

Plastics Division
General American Transportation Corporation
135 South La Salle Street • Telephone FInancial 6-4100
Chicago 90, Illinois

Offices in principal cities



New Gillette Special—razor, 6-blade dispenser and gold-plated lure packed in a plastic box fishermen and handymen will find useful.



A Bright new idea in gift packaging by Gillette —custom molded by Sylvania

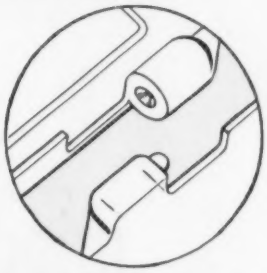
Chances are you're one of the many hundreds of thousands of fathers or fishermen to get a Gillette razor in the new plastic box gift case. If so, you've had a good close look at Sylvania injection custom molding.

You might have noticed that despite deep, thin-walled compartments, surfaces were smooth and clear and that in traditional Gillette fashion, the hinged top was securely latched but opened easily. And you probably guessed that the case was produced in high volume to meet the needs of America's gift-giving families, and Gillette shaving fathers.

A job like this calls for molding experience, facilities, and ingenuity characteristic of Sylvania. That's why manufacturers large and small take their custom-molding problems to Sylvania. Why don't you?

Write for this new brochure. It outlines Sylvania's complete custom-molding facilities, and might suggest how they can be put to work profitably for you. Write for information, too, on Sylvania's custom metal stampings; clad, plated and alloy wires; plated metal strip; custom wire welds, and special electronic components.





Snap-on hinges make it possible to mass-produce this Gillette polystyrene box in two pieces, quickly and economically snapped together to form the complete unit. Sylvania's ability to hold close hinge tolerances was an important factor in making this simplified design.

Sylvania's complete plastics services include mold making, compression, injection and transfer molding, and finishing and assembly operations.

SYLVANIA PARTS DIVISION

Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

SPECIAL WIRE | METAL STAMPINGS | MOLDED PLASTIC | ELECTRONIC COMPONENTS

4-way service from one source

Beryllium Copper
PRESSURE CASTINGS
by **FEDERAL**



- Multiple cavities and cores of intricate shape
- Raised letters that can not be hobbed in steel
- Corrosion resistant—long wearing
- Compressive strength over 200,000 PSI
- Thermal conductivity over twice that of steel



Write for Free Illustrated Folder Today

FEDERAL TOOL CORPORATION
3600 W. PLATT BLVD., CHICAGO 45, ILLINOIS

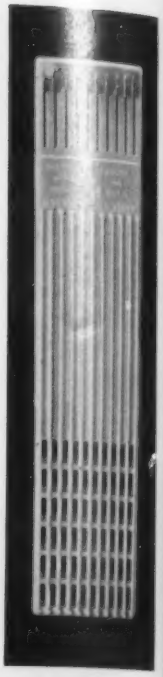
PRECISION
injection **AND COMPRESSION MOLDING**

producers of plastics for
RCA Zenith
Mitchell and others

complete facilities from
mold-making to painting
and finishing

General Die Mold Co.
548 N. SACRAMENTO BLVD. • CHICAGO 12, ILL.

Check with Chili





Chili Plastics is staffed and equipped to produce a wide variety of products. This measuring cup with cap and the fish-hook holder are two current examples. The hook holder—injection molded of styrene—has 20 aluminum clips set on springs, to hold the hooks snugly in place. The entire job, including the intricate assembly, was handled by Chili.

Next time you have a plastics problem, check with Chili first. You'll find that just discussing your plans with one of our representatives will be a helpful experience.

CHILI plastics, inc.
2278 WESTSIDE DRIVE
NORTH CHILI,
NEW YORK

Injection Molding • Vacuum Forming •
Assembly • Mold Design and Construction

IN A HURRY ? GOT PROBLEMS NEED EXPERT HELP

Spacious new MPc plant houses design, engineering facilities . . . tool room and molding departments of exceptional capacity to assure prompt and efficient handling of the largest and smallest jobs.

COMPRESSION MOLDING

Conventional press facilities provide economical solutions for the most complex requirements. Working pressures: 20 to 3000 tons. Platen areas: 18" x 18" to 192" x 84". Maximum daylight openings: 19" to 117". Preform press capacity: 8000 lb. per hour. Advanced electronic preheating equipment.



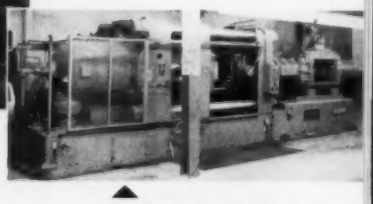


Compression molding division includes such extraordinary equipment as this side angle press, capable of producing highly complicated parts.

INJECTION MOLDING

Battery of newest type presses ranging from 4 oz. to 80 oz. make possible efficient handling of wide variety of jobs.

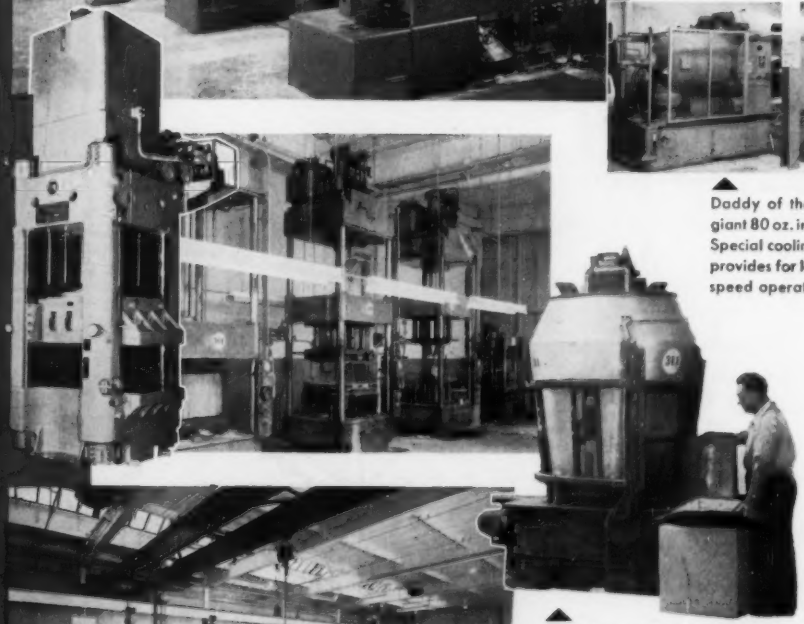




Daddy of them all is this giant 80 oz. injection press. Special cooling equipment provides for low-cost high-speed operation.

REINFORCED POLYESTER MOLDING (FIBERGLASS)

Working pressures: 50 to 3000 tons. Platen areas: 18" x 16" to 192" x 84". Maximum press openings: 19" to 117".



Fiberglass reinforcements are produced by the use of modern semi-automatic preform equipment.

MOLD MAKING

The MPc tool room is equipped with the newest types of machine tools . . . such as this radial drill . . . and has a 10-ton fully motorized overhead crane for handling heavy molds.





Product designers and purchasing agents are invited to submit specifications, plastic products or problems for study and quotation.

Write Dept. W for brochure.

MOLDED MPc PRODUCTS

Division of Admiral Corporation

P. O. Box 338, West Chicago, Illinois · Telephone: West Chicago 1140

Baby Playthings





Toddler Toys

Symbols of your potential th



Housewares



Do-It-Yourself Materials



Outdoor Living Aids

Modern House Fittings





Containers & Packaging

al through Tupper Corporation

Premiums



• Whatever your custom needs in plastics manufacturing, call on Tupper's wide experience and modern manufacturing facilities. Our large, up-to-date plants, equipped with the best production machinery, are available for materials, injection molding, extruding, vacuum forming, blow molding—and other advanced processes.

The Tupper Engineering Department has developed the greatest number of patents in the industry for polyethylene seals, closures, and dispensers—and other items in other plastics. This know-how can be tapped by you to place your plastic products in a position of leadership.

Tupper Seals and other Tupper products are protected against unauthorized manufacture by about 150 U. S. and foreign patents and patents applied for plus numerous trademarks and copyrights.

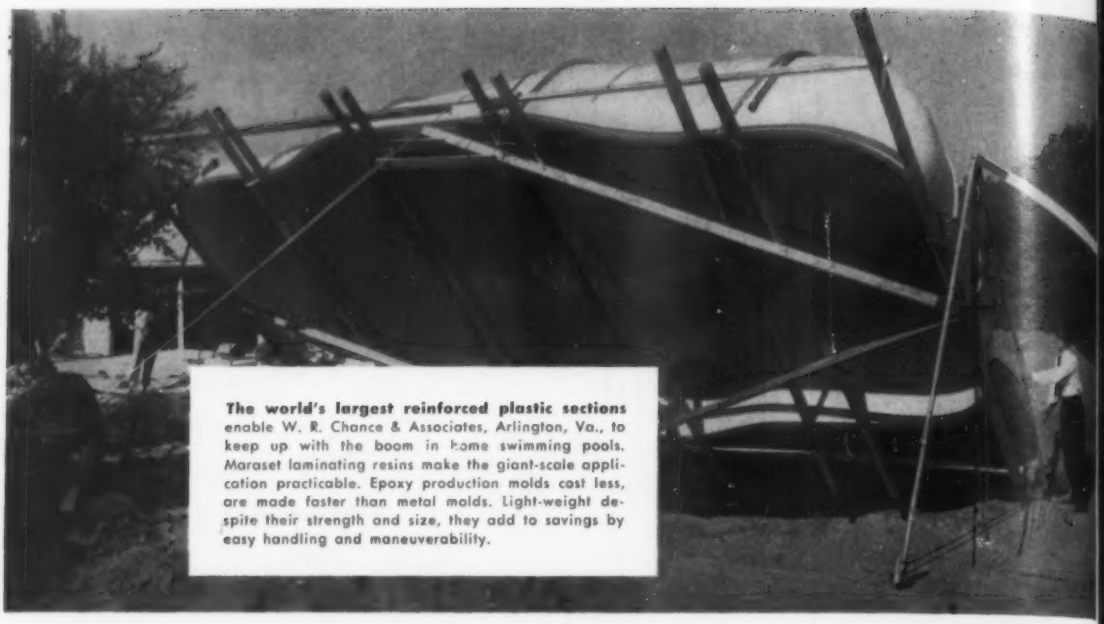
TUPPER! TRADE MARK

TUPPER CORPORATION

Manufacturers of: **CONSUMER, INDUSTRIAL, PACKAGING and SCIENTIFIC PRODUCTS**

Factories, Laboratories and Sales Offices: **Massachusetts, Rhode Island, Florida, Montreal, New York**

Address correspondence to: **Tupper Corporation, Woonsocket, R. I.** or **Tupper Corporation, 225 Fifth Ave., N. Y. C.**



The world's largest reinforced plastic sections enable W. R. Chance & Associates, Arlington, Va., to keep up with the boom in home swimming pools. Maraset laminating resins make the giant-scale application practicable. Epoxy production molds cost less, are made faster than metal molds. Light-weight despite their strength and size, they add to savings by easy handling and maneuverability.

Big and small production problems "float away" with Maraset resins

"Stay in the swim" — meet time schedules, outpace competition, develop new applications, speed up and improve manufacturing by using Maraset epoxy and Marblette phenolic resins.



Protection that aids mass production, stops delays is given by Maraset coatings to aluminum mandrels dipped repeatedly into hot liquid to make "fun balls," oxygen masks, and other thin latex products. Seamless Rubber Co., New Haven, Conn., paints the metal forms with abrasion-resistant epoxy resin that seals pores, eliminates sanding, prevents fissures that would blister and deform the rubber.

Plastic tools and dies made from standard and "specially tailored" Marblette formulations create time and labor savings as high as 80%. These versatile resins are durable, light, dimensionally stable, readily recast for design changes.

Protection for surfaces and finishes of many materials is assured by Maraset maintenance paint and varnish. These coating resins resist heat, humidity, abrasion, chemicals and corrosives.

Encapsulating and impregnating Maraset compounds offer high dielectric strength. They adhere firmly to electronic parts, cure quickly, provide a hermetic seal, guard against shock, heat, moisture, and contaminants.

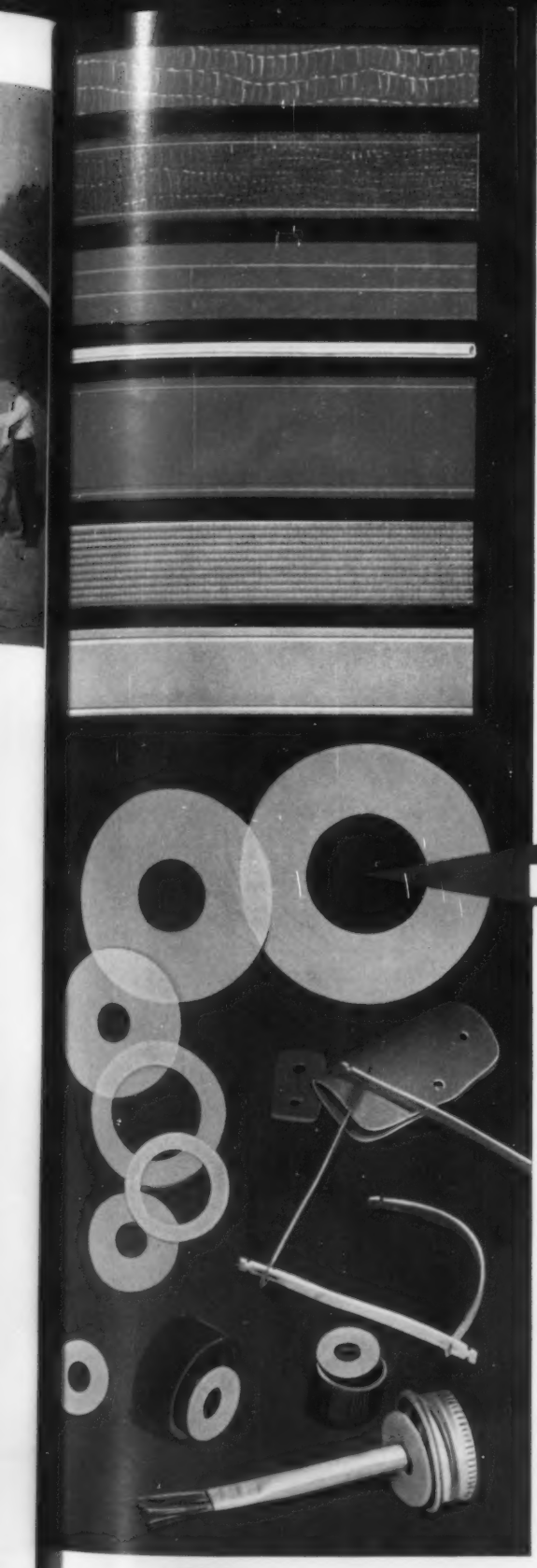
FREE — new technical bulletins on Maraset resins for casting, laminating, potting, surfacing, and other uses. Practical aid based on three decades of Marblette research can help solve your production requirements.

Write, wire or phone today:

Marblette

37-00 Thirtieth St., Long Island City 1, N. Y.
Telephone STillwell 4-8100

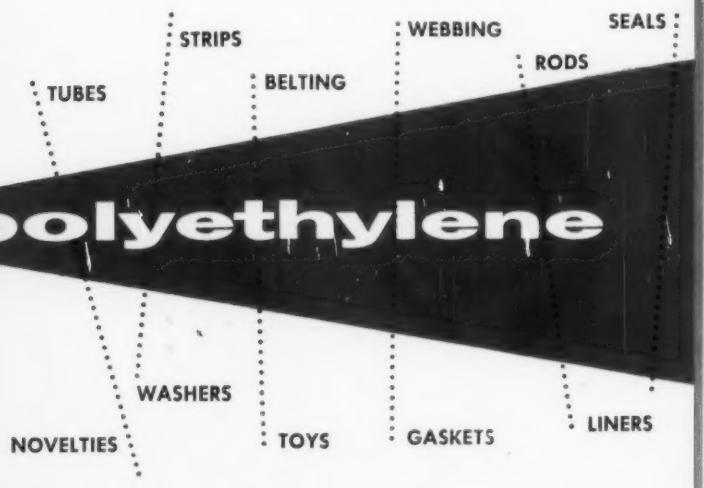
CHICAGO • DETROIT • LOS ANGELES
WICHITA • TORONTO • ROCHESTER, N. Y.



specify the size . . . we'll custom extrude it

FOR POLYETHYLENE EXTRUSIONS AND LAMINATIONS . . . in all quantities from sample cross sections to normal production runs . . . in any color required, matched and maintained with no variation . . . in countless sizes and forms . . . embossed in a wide choice of standard or special patterns . . . CONTACT CONTOUR.

FOR VYLONI, THE REVOLUTIONARY NEW HIGH LUSTRE PLASTIC . . . available in more than 2000 colors . . . with innumerable two-tone combinations as well as simulated pearl finishes . . . in widths from 1/2" up . . . approximately at the cost of polyethylene . . . CONTACT CONTOUR.



specify the shape . . . we'll automatically blank it to your order

for a process that can sizeably reduce your manufacturing cost CONTACT CONTOUR

Automatic Inline Blanking by CONTOUR actually eliminates a whole process in your production, completely does away with wasteful trim. You don't buy the extruded material. You buy the shape you specify, extruded and blanked out by CONTOUR'S special technique. Add up the savings. Then CONTACT CONTOUR.

Contour EXTRUSION COMPANY

519 FAYETTE AVENUE, MAMARONECK, N. Y.

Phone: MAmaroneck 9-6173

Sobenite

SOUTH BEND, INDIANA



One of the nation's pioneers in injection molded plastics . . . serving the country's leaders in automobiles, farm equipment, band instruments, sporting goods, hardware and other fields. Quality production . . . on time delivery . . . competitive price.

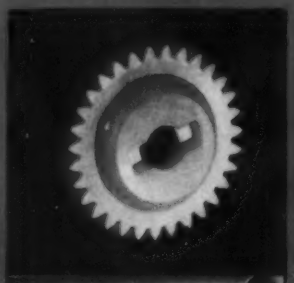
SOBENITE, INC. • 1026 KING STREET • SOUTH BEND, IND. • PHONE CE 4-0221

DANCO NYLON

MOLDINGS
EXTRUSIONS
NYLON TUBE FITTINGS
NYLON FILTERS

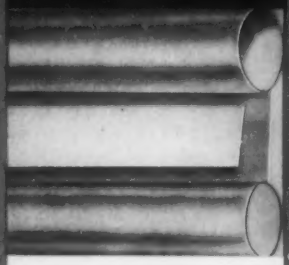
COMPLETE FACILITIES
FOR INJECTION MOLDING
EXTRUSION, MOLD MAKING

MOLDING



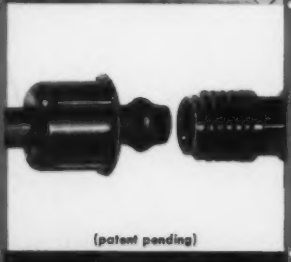
A pioneer in plastics, Danco produced the first commercial Nylon molding. Today—with greatly expanded facilities and experience—Danco molded parts include gears, bearings, structural members, cams, and an almost limitless number of Nylon parts for industry.

EXTRUSION



And in extrusion too, Danco has earned acclaim for its work in extruded Nylon. High-quality Danco extrusions— tape, tube, solid rod and pipe—are available in a wide variety of sizes and lengths . . . from stock or custom-made to particular production needs.

TUBE FITTINGS



(patent pending)

An entirely new concept, Danco tube fittings are especially designed for flexible tubing, both plastic and rubber. It's simple, fast, strong . . . requires NO SOLVENT . . . . NO CLAMP . . . and assures NO REDUCTION in I D. For elbows, tees, terminals, and other fittings, send your complete specifications to Danco for the finest in molded plastics.

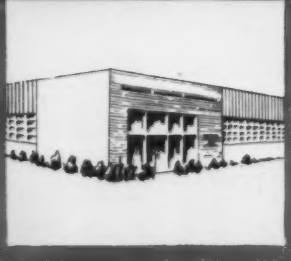
NYLON FILTERS



(patent pending)

Complete ALL-NYLON filters—with both Nylon screen and supporting structure—assure greater filtration, greater flow at lower cost. Integral screen and support, molded together in strong Nylon bond, resists corrosion and wear in hundreds of filtering applications. Ideal for filtering lube, diesel and hydraulic oils . . . water . . . gasoline . . . insecticides . . . air, etc.

NEW FACILITIES



A modern new plant doubles production area in Danielson (Connecticut). Today, Danco offers customers the combination of skilled and experienced personnel, the latest molding and extrusion machines . . . and as complete a production organization as any in the world.

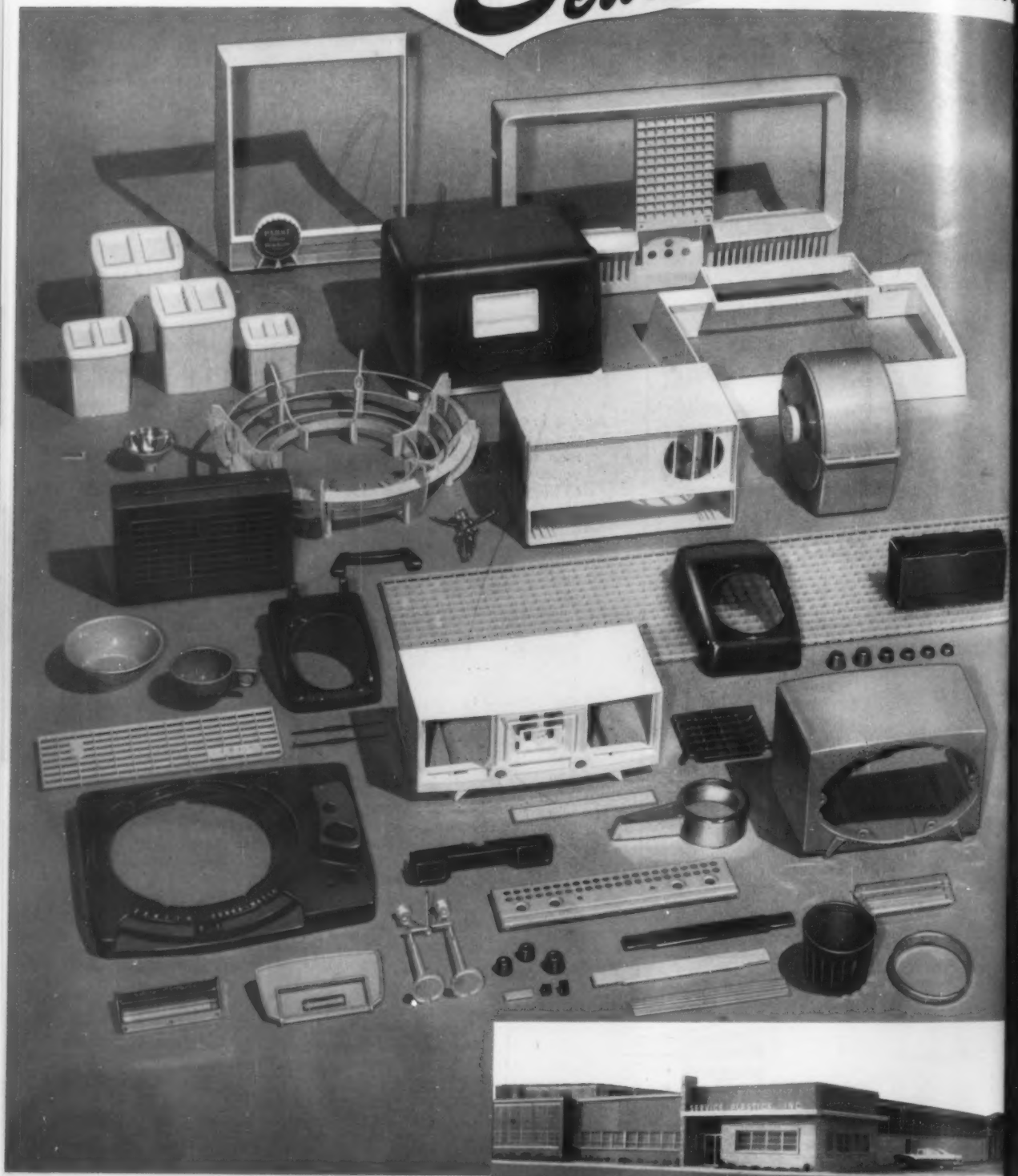
Write for your copy of new informative literature on all products shown here. Or, if you have a special problem, a Danco factory-trained representative will be glad to call.

DANCO

DANIELSON MANUFACTURING COMPANY / DANIELSON, CONNECTICUT

A SUBSIDIARY OF NICHOLSON FILE CO.

IT'S THE QUALITY OF *Service* THAT COUNTS...





Injection molders exclusively, with press capacity up to 85 ounces and complete toolroom facilities.

Service PLASTICS, INC.

Custom Molders of Plastic Parts and Products

5305-33 NORTH ELSTON AVE
CHICAGO 30, ILLINOIS



add new dimensions to salability through cardinal "see-deep"





...dustry uses Cardinal
...nger each year . . . as more
...the versatility they seek in this
unique process. ...t plastic application to offer a medium
of expression ... measures up fully to your creative originality,
Cardinal "See-Deep" continues to set the pace for transforming
... designs faithfully into truly outstanding
sales-sparking advantages.

Whatever your particular application, however exacting your requirements as to quality or costwise, see why Cardinal "See-Deep" is proved and approved by the big-name manufacturers nationwide. Our product engineers will work for you, or with you, to help you make the most of this still unmatched process. Their experienced counsel is at your command, at no cost or obligation.



write today

FOR COMPLETE INFORMATION ON

cardinal "see-deep"

MONSANTO CORPORATION
BELTON, SOUTH CAROLINA

"Let me tell you how M22 is . . .

6 ways better with AMOS PLASTICS"





stronger than metal by repeated drop tests

½ lighter than metal fans of comparable size

smoother finish, chip-proof rust-proof

quieter, no vibrating metal to create noise

color all the way through

new engineering principles made possible only with plastics

M is for Meier Electric—a name famed for product quality and dependability for over 50 years.

M22 is Meier's distinguished new portable window fan with all-plastic case. Another Meier fan "first" with the exclusive advantages listed above!

A is for Amos—a name known for many "firsts" in product redesign and engineering for plastics, including the new M22.

Y is for you—to ask whether *your product* might benefit by Amos conversion to plastics? No obligation, write, wire or phone:

Amos Molded Plastics, Dept. MPE-97, Edinburg, Indiana
Offices: Chicago, Detroit, New York City, Philadelphia, Kansas City, Mo.





Amos
MOLDED PLASTICS...
Custom Injection
Molding and Finishing Specialists

SUNLITE

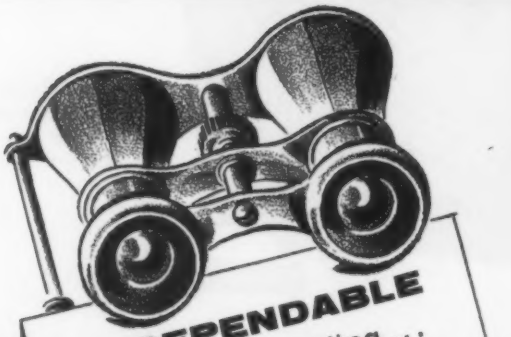
THERMOPLASTIC

EXTRUSIONS

RODS · TUBES · SHAPES

SUNLITE Plastics Inc.

1506 W. PIERCE ST., MILWAUKEE 46, WIS.



For **DEPENDABLE** Custom Molding... Look to **KINGMAN**

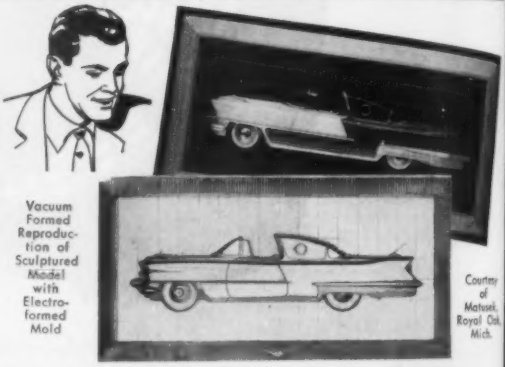
Kingman offers a complete design, engineering and molding service that assures you top quality results. And it's all experience... experience that has been product-proved time and time again. Kingman's skills and facilities guarantee the success of your sample or production runs. Write today for quotations. There's no obligation.

Injection Molding
Design Service
Fabrication
Model Making
Mold Making
Extrusion

"A Complete Custom Molding Service"

E. B. Kingman CO., INC.

96 Exchange St., Leominster, Mass.



Vacuum Formed Reproduction of Sculptured Model with Electroformed Mold

Courtesy of Matusek, Royal Oak, Mich.

For Vacuum-Forming . . . .

ELECTROFORMED METAL MOLDS

give you MORE DETAIL . . . at LOWER COST!

Electroformed Molds give you high quality . . . exact reproduction in both dimension and surface finish. No costly finishing is necessary. No "blowholes" or other imperfections. No shrinkage allowance necessary. They are perfect for production runs giving perfect heat transfer and excellent corrosion resistance.

Write for complete technical details and cost estimates on Electroformed Molds for vacuum forming, plastisol molding, slush casting and low pressure molding. Also, injection molds.

T. V. JAY COMPANY

2227 West Belmont Ave. Chicago 18, Illinois



WORLD'S LARGEST PRODUCERS OF THERMOFORMED PRODUCTS AND PACKAGES

. . . on high speed continuous automatic machinery . . . from any thermoplastic material . . . at lowest cost . . . since 1938.

PLAXALL INC.

Long Island City 1, N. Y.

SLIDEPLAX is Plaxall's name for thermo formed packages with integral slide tracks.



Disposable Specula for Ear Examination
Welch Allyn Inc.



Cups and Dishes with Snap-In Lids



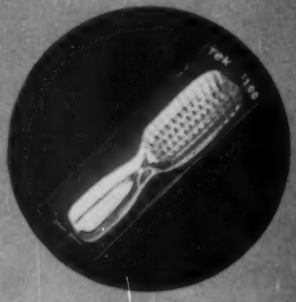
Gift and Display Cases
Chas. Briddell Inc.



SLIDEPLAX® for Rubber Gloves
Wilson Rubber Co., A Div. of Becton-Dickinson & Co.



SLIDEPLAX® Twine Dispenser
Linen Thread Co.



SLIDEPLAX® Brush Package
Johnson & Johnson



SLIDEPLAX® Dispenser for Miniature Batteries
Mallory-General-Eveready



SLIDEPLAX® Dispenser for Applicators
Q-Tips Inc.

TEFLON · KEL-F · NYLON



STOCK and FABRICATED PARTS

Profit from the "know-how" of the pioneers and leaders in the fabrication and application of the "engineered plastics"—TEFLON*, KEL-F† and NYLON (du Pont ZYTEL).

Buy from the world's most complete stock of sheets, discs, tape, rods, tubing, bars, cylinders, and extruded shapes—and the new Cementable TEFLON sheets and tape.

Or send us your blueprints for rapid, low-cost, quality-controlled production of parts to your specifications.

U.S.G. offers one of the largest and the most modern extrusion plants in America producing *bubble-free* extrusions, even in the smallest diameters.

U.S.G. offers complete facilities for annealing and for surface dyeing or pigmenting throughout, in full range of colors.

U.S.G. offers an extensive injection molding plant with machines ranging in capacities up to 8 oz., and specializing in difficult precision moldings in volume production with accompanying economies.

U.S.G. offers a complete, high-speed plastics machining plant, geared to part quantity requirements from the prototype stage to full scale production.

Whatever your plastics part requirements—check your methods and costs with U.S.G. "know-how". Write for Bulletin IN-1256.

United States Gasket Company

Camden 1, New Jersey

**du Pont Trademark*
†Minn. Mining & Mfg. Trademark

United States Gasket

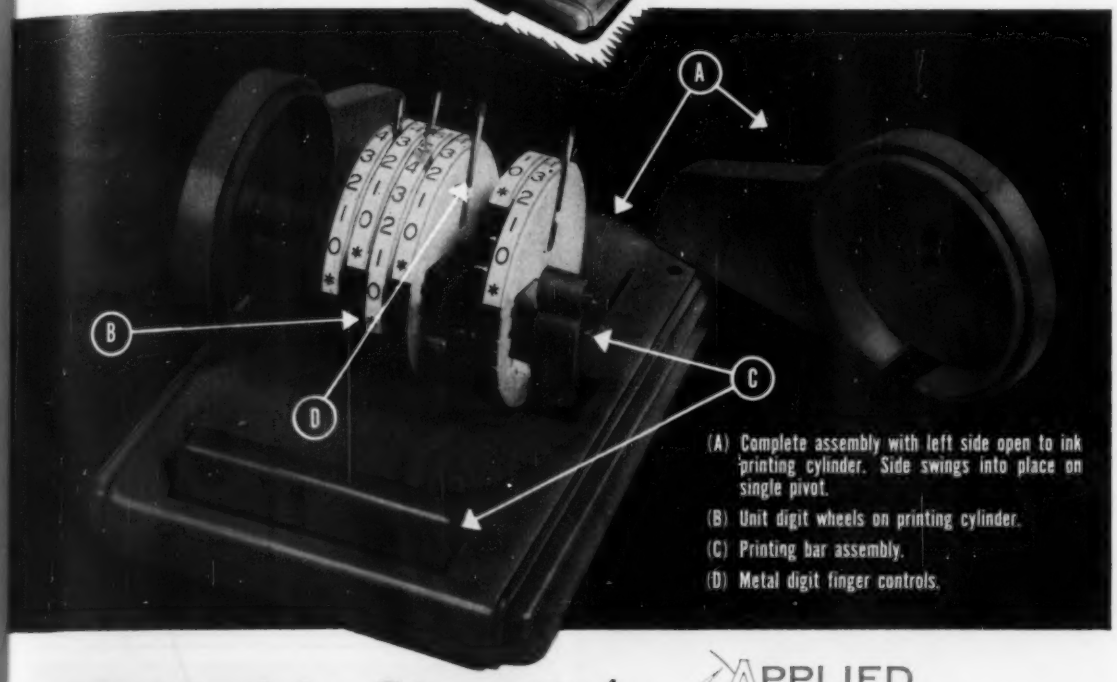
Plastics Division

OF THE GARLOCK PACKING CO

NEW **PERMAPRINT** CHECK PROTECTOR



Low Cost Check Protector



Molded in Styrene *for* APPLIED RESEARCH CORPORATION

The new "Perma Print" Check Protector, marketed by The Applied Research Corporation, prints thousands of checks without re-inking. The result is completely professional and impressive in every way

This handy check writer had to be inexpensive, lightweight, sturdy and absolutely reliable. Its cost must be low to give small retailers, professional men and even householders check protection. Quinn-Berry engineers were chosen for this job.

Here you see illustrated the many molded styrene parts and their function in the complete assembly. Precision engineering backed up by dimensionally stable thermo-plastic molding proved to be the desired answer.

Again a Quinn-Berry achievement in an unusual molded plastic application . . . proving, of course, that at Quinn-Berry the "Unusual is Routine."

DETROIT 27, Mich.
Harry R. Brethen
14231 Puritan Avenue
Broadway 3-8964

WYNNEWOOD, Pa.
Austin L. Wright
P. O. Box 12
50 East Wynnewood Road
Midway 2-5113

MILWAUKEE 13, Wis.
John Weiland, Jr.
7105 Grand Parkway
Greenfield 6-7161

EAST ROCHESTER, N. Y.
Dynatherm, Inc.
607 West Commercial Street
Phone: Hillside 5-0626

DAYTON 9, Ohio
G. Ross Vines
637 Monteray Avenue
Adams 8161

CHELSEA 50, Mass
Joseph Leader
68 Marlborough Street
Chelsea 3-3484

CHICAGO, Illinois
R. H. Frish
Room 211
6349 Northwestern Ave.
Ambassador 2-6005

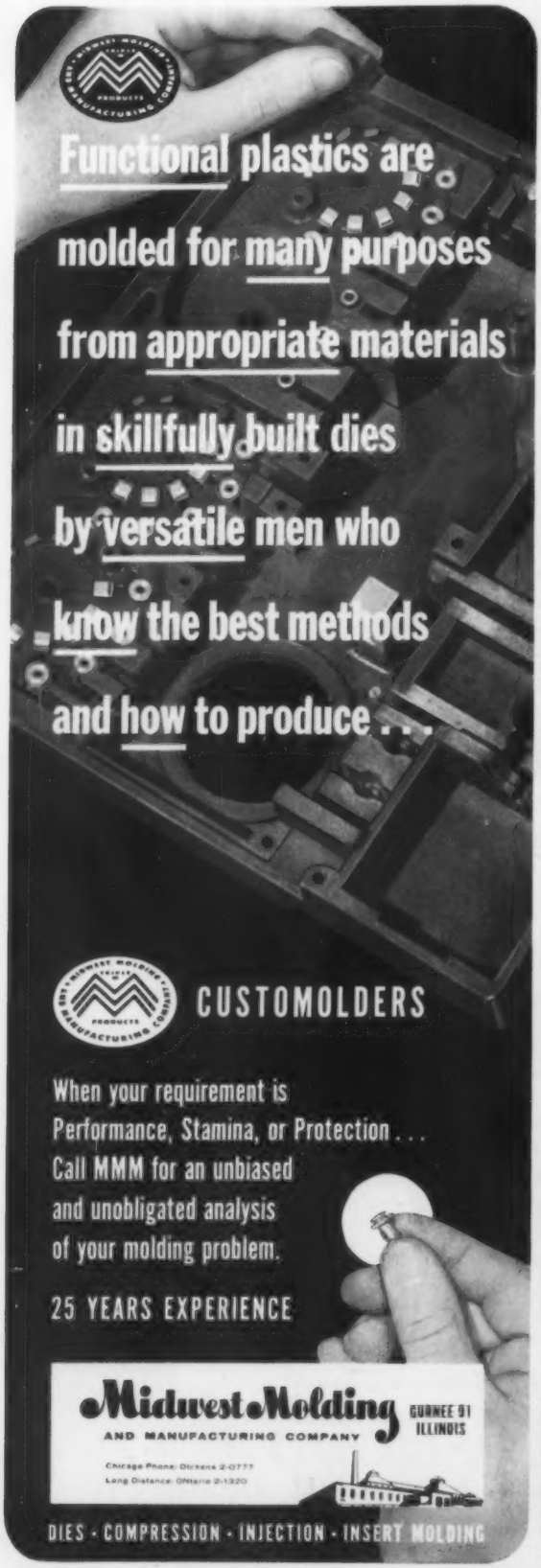
KNOXVILLE, TENNESSEE
Harold Mellay
7028 Rockingham Drive
Phone 8-5155



WE FLY TO SERVE YOU FASTER!



QUINN-BERRY CORP.
2609 WEST 12TH STREET, ERIE, PA.
CUSTOM MOLDERS OF ALL TYPES OF THERMOPLASTICS



CUSTOMOLDERS

When your requirement is
Performance, Stamina, or Protection . . .
Call MMM for an unbiased
and unobligated analysis
of your molding problem.

25 YEARS EXPERIENCE

Midwest Molding AND MANUFACTURING COMPANY
GURNEE 91 ILLINOIS
Chicago Phone: Dickens 2-0777
Long Distance: Ontario 2-1320

DIES · COMPRESSION · INJECTION · INSERT MOLDING

LIBERTY MOLDS
are better by design

•

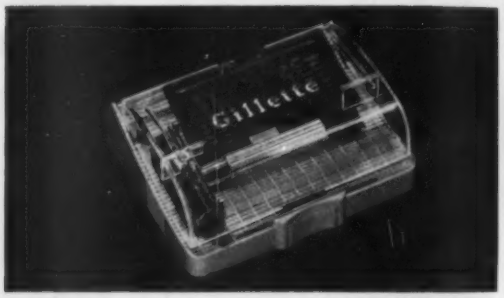
Plastic Molds
for every operation

COMPRESSION
INJECTION
TRANSFER

•

The skill of experience has made Liberty tops in mold making. Using the latest in modern equipment, Liberty can make all types of plastics molds (including hobs and hobbings) to your complete satisfaction.
You are assured of precision work at a reasonable price.

LIBERTY TOOL & MACHINE CO.
18 South 20th Street • Irvington 11, N. J.
Phone ESsex 4-0600
WE SPECIALIZE IN CUSTOM BUILT MOLD BASES



THE GILLETTE SAFETY RAZOR CASE—
A NOTABLE EXAMPLE OF NATIONAL

CUSTOM MOLDING

Leading manufacturers, like the Gillette Safety Razor Co., have availed themselves of National's vast facilities, know-how and experience in precision custom molding.

Staffed by skilled engineers, National's molding division offers a complete service in the production of factory-perfect molded plastics to exact specifications. Your inquiry will receive prompt attention.

MOLDING DIVISION:

The NATIONAL *Plastic Products Company*

Saran & Nylon Filaments — Nevamar High-Pressure Laminates — Wynene Extruded & Molded Products
ODENTON, MD. • NEW YORK, N. Y. • LOS ANGELES, CALIF. • MIAMI, FLA.

SINCE 1919

When it comes to PLASTICS



Emeloid REALLY DOES A JOB!

WHAT'S YOURS?

- LITHOGRAPHY
- EMBOSSING
- PRINTING
- STAMPING
- BUFFING
- LAMINATING
- MACHINING
- CUTTING
- COATING
- ASSEMBLY

Injection Molding

Vacuum Forming

Die-Cutting

Complete Equipment



These are a few of the TYPES of molding and allied operations in which we excel — excel because of long, l-o-n-g experience — plus constant modernization of equipment for purposes of more versatile and economical production — plus management and personnel whose know-how goes 'way back — plus an engineering staff that may, at your desire, help improve your product.

SPARK-o-LOID! Sheeting for decoration of vanity cases and wallets, shoes, handbags, etc.

40,000 sq. ft. in a modern plant with ultra-modern equipment . . . finest in the east.

ALL PRODUCTION DONE AT EMELOID..... BY EMELOID



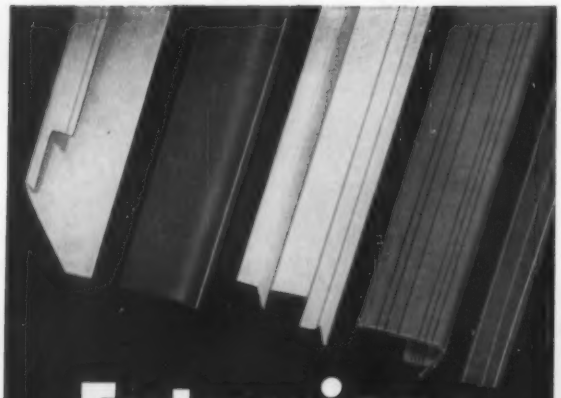
Emeloid

HILLSIDE 5, N. J.

PLASTICS SINCE 1919

Phones:
ELizabeth 2-1944 - 1945 - 1946
WAverly 3-4341 - 3-4342 - 3-1958
N. Y. City—REctor 2-8554 - 8555
Cable: "TEC" HILLSIDE, N. J.

• DESIGNS • DEVELOPS • PRODUCES



Extrusions

Schwab Plastics Corp. offers complete facilities for the quality production of custom extruded shapes, including multi-colored and metallic insert extrusions, to your specifications.

ACETATE • BUTYRATE • NYLON • ACRYLIC
VINYL • POLYETHELENE • POLYSTYRENE

SCHWAB

PLASTICS CORPORATION

730 S. DIX AVE. • DETROIT 17, MICH.

PHONE VINEWOOD 2-2870

Schwab Plastics Corp. has developed specialized machinery for the mass production of foam plastic products on a low-cost basis from a wide variety of foam raw materials.

STYRENE • POLYURETHANE
ACETATE • VINYL

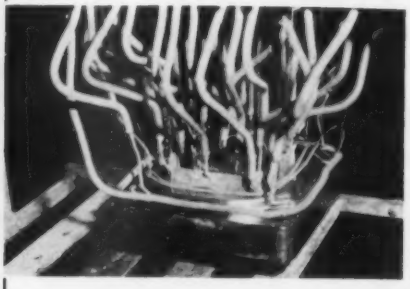
INQUIRIES INVITED

Foam Plastics



NUTMEG . . .

pioneers in POLISHING and CHROME PLATING of PLASTIC MOLDS



A good illustration of the complexities involved in mold plating.

NUTMEG CHROME CORPORATION

111 Vanderbilt Avenue, West Hartford 10, Conn.
Phone: CHapel 6-5411



When you call on PLASTIC MOLDING CORPORATION for your custom molding needs, you can be certain your inquiry will receive fully individualized attention, because we are staffed and equipped for all six major molding methods.

AUTOMATIC • COMPRESSION • TRANSFER
PLUNGER • INJECTION • COLD MOLD

This flexibility enables us to process each order by the method and with the material best suited for the job's particular needs. You'll be well satisfied with our pricing and delivery, too. So why not let us quote on your next molding requirement?

Plastic Molding Corporation Sandy Hook Connecticut

Molders of plastics for over a quarter century

Santay DELIVERS MORE

For your Molding . . . Engineering . . . Tooling . . . Stamping . . . Assembly and Finishing Dollars



You save time and money because Santay performs all operations under one roof. From the conception of the idea, design and tooling, through the finished assembly, you deal with just one, well established, competent firm.

You pay only one freight bill, you deal with only one supplier, one production schedule carries the job to completion. Santay saves you both time and money.

Write for our free Plastic Buyers' Guide Booklet.

Whatever your requirements, large or small, simple or complex . . . the complete staff of Santay is ready to serve you.

Santay Corporation

355 N. CRAWFORD AVENUE, CHICAGO 24, ILLINOIS

Santay — SYMBOL OF PRECISION CRAFTSMANSHIP

REPRESENTATIVES:

Jack Baran 363 Capen Boulevard Eggertsville, N. Y.	Drew and Drew 1619 First Ave. S. E. Cedar Rapids, Iowa	E. J. Edmunds 101 N. Lexington St. Havertown, Pennsylvania	Queisser Brothers 110 East Ninth St. Indianapolis, Indiana	Wm. S. Richards Co. 2 S. Brentwood Blvd. St. Louis, Missouri	Ray A. Scharer & Co. 3000 East Grand Blvd. Detroit 2, Michigan



YOU CAN SAVE BY SWITCHING TO MIDLON



If your plastic costs are excessive . . . check with Midwest, the nation's largest and oldest exclusive extruder of thermoplastic sheet.

Here at Midwest, specialization has paid off . . . not only in quality of product but also in lowered costs. This experience coupled with volume has saved thousands of dollars for many Midwest customers.

Price, quality or service . . . whatever your problem in plastics . . . there is a Midlon sheet to fit your needs precisely. That is why "Midlon or equal" so often appears in the specification sheets of major manufacturers.

Price and product information furnished promptly upon request.

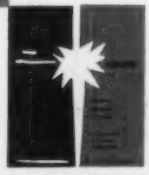
MIDWEST
PLASTIC PRODUCTS COMPANY
1801 CHICAGO RD., CHICAGO HEIGHTS, ILL.

Morningstar Custom Plastic Molders

DEVELOPMENT: Complete product development service.

FACILITIES: Complete design, molding, assembly, decorating and finishing.

EXPERIENCE: Wide range of consumer and industrial precision molded products.



This new brochure which tells the complete story is available. Write Dept. A.

THE MORNINGSTAR CORPORATION, 156 SIXTH STREET, CAMBRIDGE 42, MASS.

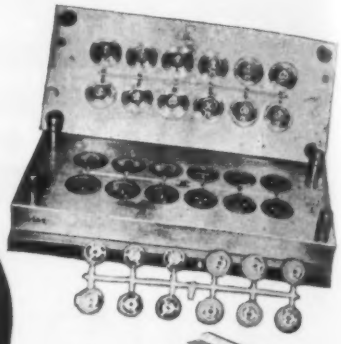
SAVE TIME AND MONEY!
SEE YOUR PRODUCT BEFORE MAKING THE MOLD

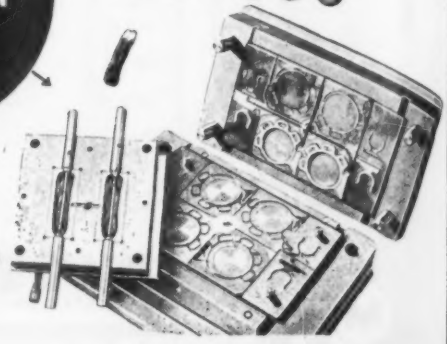
We Create
PRE-MOLD MODELS
From Your Ideas or Designs





and Follow Through with Quality-Tested
PRODUCTION MOLDS
to the Finished Product





We Specialize in
INJECTION
COMPRESSION
& TRANSFER
MOLDS

STRICKER-BRUNHUBER CORP.
Mechanical Developers
19 WEST 24th ST. NEW YORK 10, N. Y.
WAtkins 9-0191

PLATING ENGINEERING CO.
now offers
A Midwestern Source
for
Electroformed Metal Molds for
Plastisols or Vacuum Forming

Low cost. Extremely accurate detail. High heat transfer—means rapid cure. Process good for multiple molds. You furnish wax or plastic pattern.

SEND print for free estimate
Sample mold (medium size) from your pattern $25.00
Electroforming in copper and nickel

PLATING ENGINEERING CO.
1928 South 62nd St. Milwaukee 19, Wis.
Phone: Evergreen 4-4848

Custom
• INJECTION
MOLDING Parts & Products

Years of Experience and Know-How plus Modern Facilities are Your Assurance of
DEPENDABLE
LOW COST
SERVICE

"From Design To Finished Product"

Plura
PLASTICS
17-21 NEWARK WAY
MAPLEWOOD, N. J.
SOuth Orange 2-4242

There are many

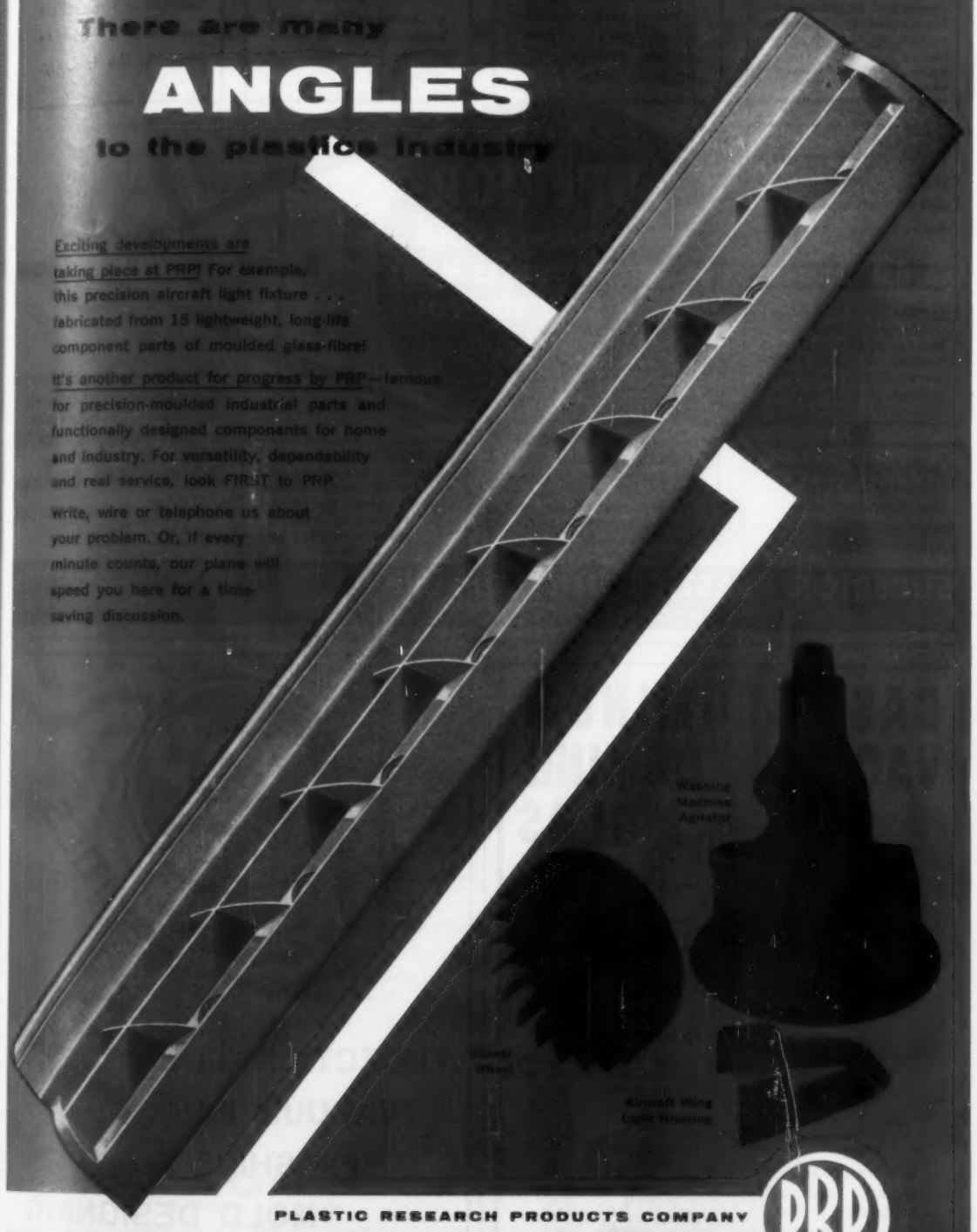
ANGLES

to the plastics industry

Exciting developments are taking place at PRP! For example, this precision aircraft light fixture . . . fabricated from 15 lightweight, long-life component parts of moulded glass-fibre!

It's another product for progress by PRP—famous for precision-moulded industrial parts and functionally designed components for home and industry. For versatility, dependability and real service, look FIRST to PRP

Write, wire or telephone us about your problem. Or, if every minute counts, our plane will speed you here for a time-saving discussion.



PLASTIC RESEARCH PRODUCTS COMPANY

PRP

Division of Scioto Manufacturing Company

Custom Moulders of Plastics · Urbana, Ohio

INJECTION MOLDING—EXTRUDING—FINISHING

SUPERIOR'S skilled designers and engineers are experienced in the most modern methods of estimating costs and designing tools for your specific needs.

SUPERIOR'S complete facilities give you better efficiency . . . production savings . . . faster delivery.

SUPERIOR'S many years of "know-how" has helped make famous brand names successful—IN EVERY INDUSTRY!

SUPERIOR'S excellent reputation is second to none in the industry.

SUPERIOR has one of the most up-to-date and well equipped tool shops in the midwest.

WHY SUPERIOR CAN PRODUCE YOUR PLASTIC PRODUCTS MORE PROFITABLY FOR YOU —at lower cost!

SUPERIOR'S injection molding department is the best equipped — most diversified . . . solves every thermoplastic material problem up to 32 ounces.

SUPERIOR'S extrusion department also has the latest, most modern equipment and machinery available.

SUPERIOR'S quality control and inspection department personally control the production of your job from start to finish—insuring high quality product requirement.

SUPERIOR'S production lines have been designed so flexibly they can be quickly re-arranged to adjust to varying finishing operations as required for different products.

We are also specialists in the producing of advertising specialties and volume premiums on package inserts.

PHONE OR WRITE TODAY FOR *Free* FACILITIES FOLDER!

SUPERIOR PLASTICS INC. Dept. 300
SUPERLON PRODUCTS

410-430 NORTH OAKLEY BOULEVARD
CHICAGO 12, ILL. • PHONE: CANAL 6-4540

CAST ALUMINUM VACUUM FORMING MOLDS



Pattern and finished mold for refrigerator door liner

From Your Prints

to . . .

Precision Wood Pattern

for accurate checking of appearance and dimensions, to . . .

Finished Molds

cored for cooling, gasketed, drilled with vacuum holes, ready to run

Reliance builds highest-quality molds for leading vacuum formers. We are equipped to do every phase of the job on both small and large molds. Fast, reliable service. Send prints for quotation.

RELIANCE PATTERN WORKS
4350 W. Chicago Ave., Chicago 51, Ill.
BEImont 5-4124

PEP INC.

COMPLETE FACILITIES

FOR

*INJECTION MOLDING
*VACUUM FORMING
*FINISHING
*MOLD DESIGNING

PORT ERIE PLASTICS, INC.
561 E. 18th ST. ERIE, PENNA.

Norton is set up for more than compression and injection molding. An experienced, flexible assembly group is available for handling the operations that come *after* the plastic moldings are completed. Because of these assembly facilities we relieve many of our customers of burdensome, time consuming work. We are often called upon to assemble either parts or entire products.

Here's an example of a completely Norton assembled product. After molding the handle, Norton assembled all the units into ready-to-sell electric fry pans.



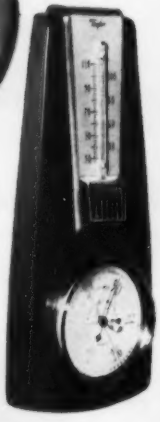
Molding—and the steps that follow, too

For more than a quarter of a century Norton has been custom molding all types of products and components for the nation's leading organizations. They have learned to rely on Norton's design service, technical skill, superior workmanship, and prompt delivery.

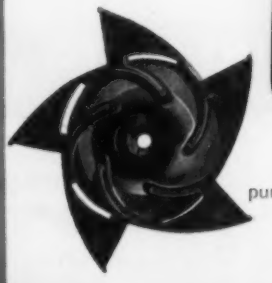
And these other recent jobs illustrate the varied type of moldings Norton turns out.



fan housing



barometer frame



pump impeller

Norton Laboratories, Inc., Lockport, New York
Sales Office: New York—175 Fifth Avenue
(Chicago) Elmhurst, Ill.—203 Elm Square Building
Cleveland—20605 Kings Highway
Detroit—7-266 General Motors Building
Philadelphia—4719 Longshore Street
Rochester—739 Powers Building

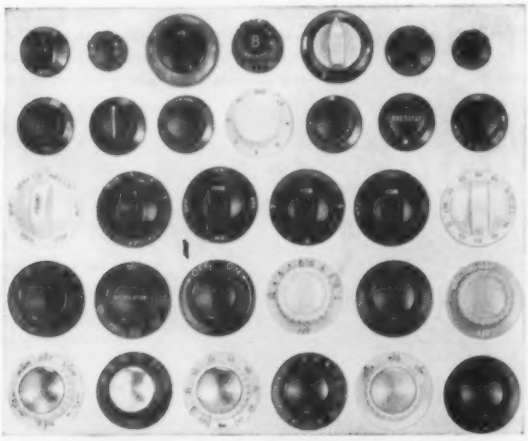
Companies you can trust
...trust Norton

NORTON

Laboratories, Inc.

COMPRESSION AND INJECTION MOLDING

PLASTIC MOLDED KNOBS



AVAILABLE FROM STOCK MOLDS, OR CUSTOM MOLDED TO YOUR OWN DESIGN

Huge selection of shapes, sizes and colors available from stock molds. No tool charge, fast delivery. Can be modified or supplied with special shaft holes at nominal cost. Markings can be branded to specifications. Special knobs can be custom-molded to your own design. Send for free catalog.

Complete Custom Molding Service

ROGAN BROTHERS

8031 N. Monticello Ave., Skokie, Illinois

Pioneer Molders of ZYTEL* and KEL-F†

†Trade name of M. W. Kellogg Co.
*"Zytel" is the new trade-mark for Du Pont nylon resin.

(Capacities 4 to 100 oz.)



We mold all THERMOPLASTICS

Our services include Design and Engineering; Mold Construction; Metal-Plastic Assemblies; 2 and 3 color Plastic Spraying and Painting; Hot Stamping; Vacuum Distillation Plating; Fabricating & Assembling

SINKO MFG. & TOOL CO.
7310 W. WILSON AVE. • CHICAGO 31, ILLINOIS

BRANCH OFFICES:

MILWAUKEE 3, WIS.
RICHARD P. VALLEE—2302 W. Clybourn St.

DAVENPORT, IOWA
WILLIAM R. VOSS—3818 Johnson Ave.

LOS ANGELES 23, CALIF.
LITTRELL SALES CO.—3121 East Twelfth St.

CLEVELAND 11, OHIO
GEORGE L. HERRICK CO.—15326 Lorain Ave.

PROVIDENCE, R. I.
MILTON PAISNER—103 Industrial Trust Bldg.

ATLANTA 5, GA.
J. P. HUNTER—P. O. Box 372, 311 Buckhead Ave.

SAN FRANCISCO, CALIF.
LITTRELL SALES CO.—115 New Montgomery St.

HADDONFIELD, N. J.
TOM MUCKENFUSS—351 Kings Highway



FREE SAMPLES

SHAW TECHNIQUES GIVE BETTER RESULTS

Benefit from our wealth of experience with all plastics. If you have a design problem, we'll be glad to send you molded samples in the material you are considering. Check below and mail this ad, or write us about your project.



SAMPLE CHECK LIST

- ☐ polyethelene
- ☐ acetate
- ☐ styrene
- ☐ alkyd
- ☐ butyrate
- ☐ phenolic
- ☐ melamine
- ☐ urea
- ☐ nylon
- ☐ acrylic
- ☐ polyesters
- ☐ ethyl cellulose





Shaw's unexcelled reputation as a custom molder extends over half a century. Perhaps our experience and advanced facilities can help you.
SHAW INSULATOR COMPANY, 144 Coit St., Irvington, N. J., and Stroudsburg, Pa.

SEND FOR BROCHURE

"SHAW takes the problems out of plastic molding."



SHAW

custom molds all plastics
by TRANSFER • COMPRESSION • INJECTION

MD DE

nobody **ever**

moves to new and

smaller quarters





HERE

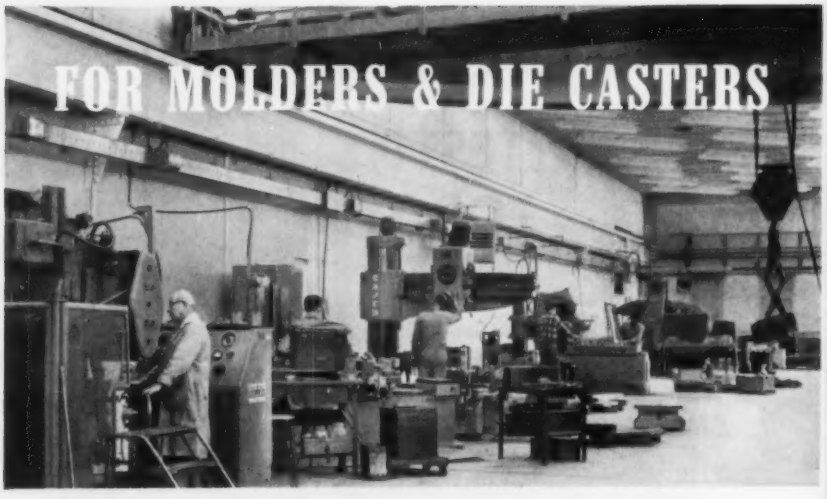
are some looks at Midland's increased facilities for tooling large or small capacity molds for precision-minded molders.

HERE

molds & dies are made by men who have made the business a career.

HERE

is the industry's source for intricate and precise molds for producing intricate and precise units. Midland as always is ready to quote or discuss your mold or die problems.



PLASTICS MOLDS • DIE CAST DIES • HYDROTEL AND PANTOGRAPH MILLING • HOBBED CAVITIES • STEEL STAMPS • ENGRAVED DIES

MIDLAND DIE & ENGRAVING DIVISION • PREX CORPORATION • FRANKLIN PARK ILLINOIS

Belmont Avenue and Wolf Road
NAtional 5-6900





"TOMORROW'S PRODUCTS TESTED TODAY"®

We are now serving leading plastics companies throughout the United States, Canada and England.

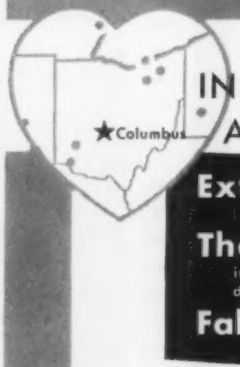
Southeastern Florida offers the best location in the United States for naturally accelerated actual weathering and sunlight exposure tests. Quick predetermination of permanency and durability is possible at all times of the year. *Write us today for full information.*

SOUTH FLORIDA TEST SERVICE

4201 N. W. 7th Street Miami 34, Florida

TESTING — INSPECTION — RESEARCH — ENGINEERS

Est. 1931



...AT THE HEART OF INDUSTRIAL AMERICA

Extruded Plastics shapes, profiles, rods, tubing

Thermoforming including vacuum process — deep drawing of plastic sheet

Fabrication polystyrene, acrylic, butyrate, acetate

for PACKAGING • DISPLAY • APPLIANCES

Some of the nation's largest firms (and smallest) let us solve their plastics problems... If we were the bragging type, we'd brag most about our ingenuity. **Call or write for details — and prices.**

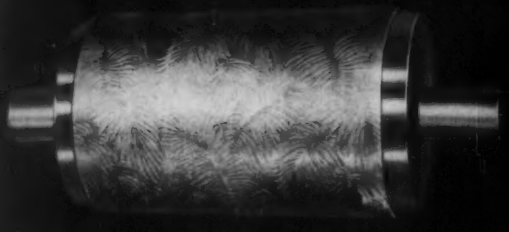
Vacuum Plastics CORPORATION

1096 SCOTT STREET • COLUMBUS 22, OHIO
PHONE CA 8-2214

IMPROVED PRODUCTS
THROUGH IMPROVED SURFACE FINISHES

Chromium plating adds superior finish and durability to...

- embossing rolls
- press plates
- molds
- casting drums
- press rams
- press platens



write for specialized information

CRODON

CHROMIUM CORPORATION OF AMERICA

100 Park Avenue, New York 17, N. Y.

PLANTS

Waterbury • Cleveland • Chicago

COOK *sets the pace*
FOR QUICK DELIVERY
of sample molds FOR PILOT RUNS

Quick Service for Sample Molds

Cook Creations Are Fairly Priced

Complete Designing and Production Facilities

Experts In Transfer, Compression, and Injection Molds

Experienced Engineering Department

Precision Workmanship On Intricate, Small, Or Medium Molds

The Better the Mold—the Better the Quality—and Higher Rate of Production and the Lower Price per piece. The Merit of all Cook Molds is in our sincerity of purpose to do everything humanly possible to manufacture the best Molds in their respective fields to our customer's complete satisfaction.

WRITE FOR COMPLETE INFORMATION AND CATALOG

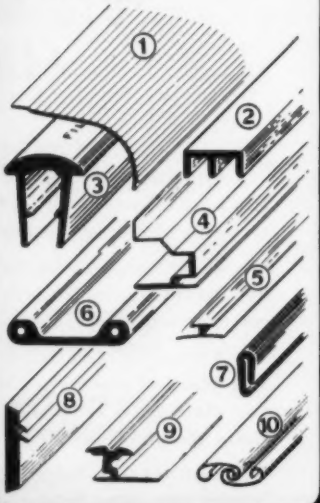
LAWRENCE H. COOK, INC.

65 Massasoit Avenue, East Prov., R. I.

ANCHOR PLASTICS EXTRUSION NEWS

COMPLEX SHAPES

Some new applications for precision extruded SHAPES are: 1) Freezer Light Cover; 2) Sliding Door Tracks; 3) Air Conditioner Filter Holder; 4) Rail Coach Shade Guide; 5) Wall-panel Joint; 6) Manometer Body Tube; 7) Rotary Index Handle; 8) Name Plate Holder; 9) TV Cabinet Moulding; 10) Tambour Door Extrusion. You can get a more detailed description by reading our brochure EXTRUDED PLASTICS.



We extrude to YOUR specifications any SHAPE, ROD, TUBE or MOULDING; also CURVED EXTRUSIONS*, FABRICATED EXTRUDED PARTS, in any of 12 plastic materials.

- Extrusion dies made in our tool room, usually between $45-$200
- Send us your prints for quotation
- Write for your copy of Extruded Plastics on company letterhead

PAT.

ANCHOR PLASTICS CO., INC.

36-36 36th Street

Long Island City 6, N. Y.

PERRY PLASTICS



INJECTION • COMPRESSION
TRANSFER • FIBERGLASS

DESIGN
DIE MAKING
FINISHING
ASSEMBLY

Each day thousands of precision parts, destined for the best names in industrial America, pour from a battery of 22 modern molding machines.

Whether you require five fiberglass truck bodies or five million precise nylon gears, your inquiry will receive our sound engineering advice and prompt quotation.

A resident Ordnance Inspector's office in our plant, and years of experience in exacting Defense Work assures our customers of satisfaction if Government Specifications are involved.

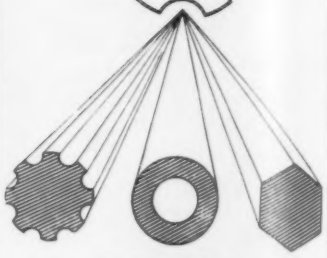
Contact our Sales Office nearest you or write direct. Names you trust—trust Perry Plastics.

SALES OFFICES: Ed. Linhart and Son, P. O. Box 366, Hershey, Pennsylvania
Earl M. Hovey and Associates, 4346 N. Woodward, Royal Oak, Michigan
Small Parts Manufacturers Co., 182 Rumstick Rd., Barrington, Rhode Island

PERRY PLASTICS, INC.
ERIE, PENNSYLVANIA

ROTUBA
FOR RODS

HEAVY EXTRUDED SECTIONS



PANELS FOR FLUORESCENT FIXTURES

Rotuba is a pioneer and a specialist in the extrusion of heavy plastic rod for every purpose. You will find that Rotuba can fill your requirements fast and at low cost.

Look to ROTUBA for

RODS • TUBES
BARS • SHAPES
TOOL HANDLES

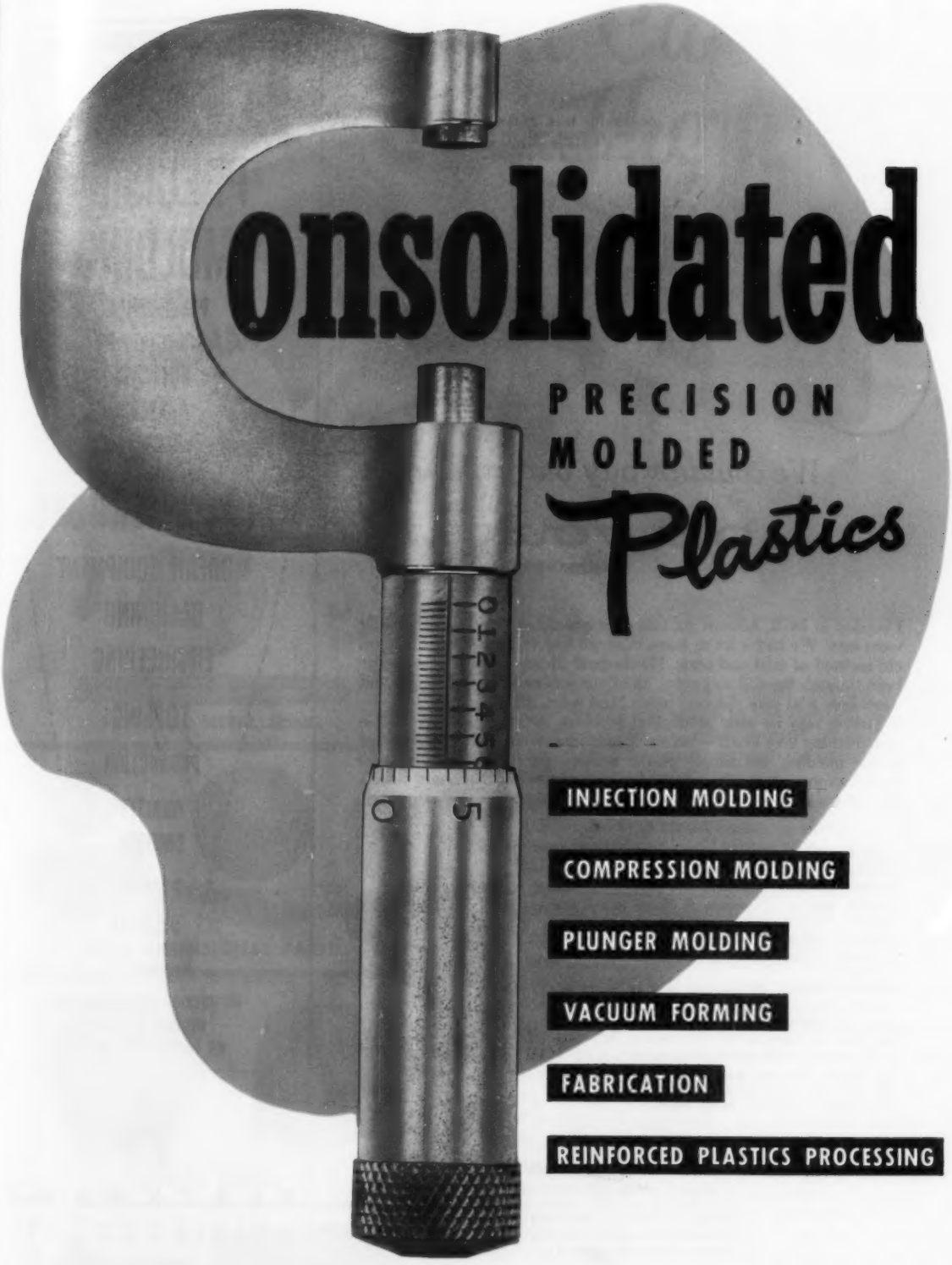
made of

TENITE BUTYRATE
CELLULOSE ACETATE
ETHYL CELLULOSE
STYRENE
ACRYLIC
RIGID VINYL

Write for Quotations to

The ROTUBA EXTRUDERS, Inc.
division of

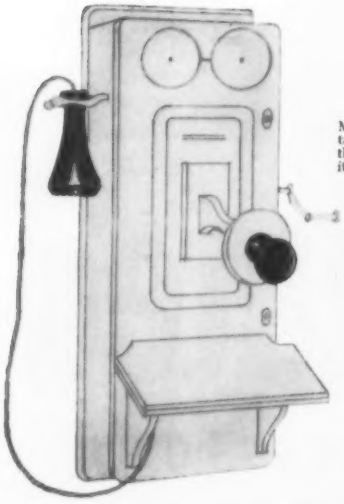
W
WALJOHN PLASTICS Inc.
430-88th STREET, BROOKLYN 9, N. Y.
SHore Road 8-5458
LEADERS IN THE FIELD OF EXTRUDED PLASTICS



CONSOLIDATED MOLDED PRODUCTS CORPORATION

SCRANTON 2, PA.

807



Mr. Bell's long distance talking machine was one of the first users of plastics in its receiver and mouthpiece.

We couldn't buy *our experience*

. . . but you can!

Founded in 1876, Auburn got into plastic molding when plastics really were new. We had a lot to learn. And we had to learn it by the good old method of trial and error. Headaches? Plenty of them! But we've been through the mill and every bit of our accumulated knowledge and know-how is at your disposal today. And we're still learning!

Whatever may be your production problem, we've probably met it — or something very like it — before. Using *every* recognized technique of plastic molding, we supply plastic molded parts to more than 400 American manufacturers, many of whose names are household words. For information on *any* phase of plastic molding, write Auburn today.

Automatic Rotary 10 automatic rotary presses can turn out millions of small parts (less than 4 sq. in.). Minimum quantities 100,000.

Transfer Molding 21 presses of 75 ton to 600 ton capacity. For fast, flash-free molding of thick or intricate phenolic pieces containing inserts.

Compression Molding 70 presses of 50 ton to 600 ton capacity.

Injection Molding 21 machines of 1 oz. to 22 oz. capacity.

Extrusion Molding Smooth, lustrous styrene sheets in any color in widths to 51", thickness to 1/16". Odd profile shapes, tubes, rods or strips in vinyl.

Tool Room Complete mold-making facilities in our own tool room make for good delivery of new molds and proper maintenance of old molds.



Today's phone, with its style, color and durability, illustrates the tremendous progress made in the plastic molding field.

PROTECT YOUR PRODUCT WITH PLASTISOL

A plastisol coating will protect your product from corrosion and abrasion and will provide a high-gloss, easily-cleaned surface. Auburn offers plastisols for coatings in a wide range of colors. Coatings that strip, coatings that can't be stripped; coatings that can be sprayed on.

api AUBURN PLASTICS, INC.
AUBURN, NEW YORK
FORMERLY AUBURN BUTTON WORKS, INC.

NYLON PRECISION MOLDING

POLYETHYLENE
POLYSTYRENE
BUTYRATE
ACRYLICS
ACETATE

LOW OVERHEAD

MODERN EQUIPMENT
DESIGNING
ENGINEERING
TOOLING
PRODUCTION
QUALITY CONTROL
PROMPT DELIVERY

ENGINEERING SERVICE AVAILABLE
WITHOUT OBLIGATION
WE INVITE YOUR INQUIRIES



BLACKHAWK MOLDING CO., INC.
COMMERCIAL RD.
ADDISON, ILLINOIS

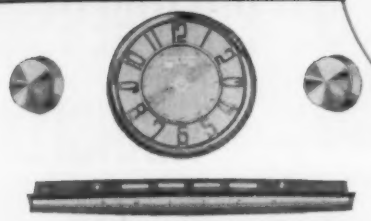
You Can Get Them All in ERIE plastics

EXTERNAL METALLIZING

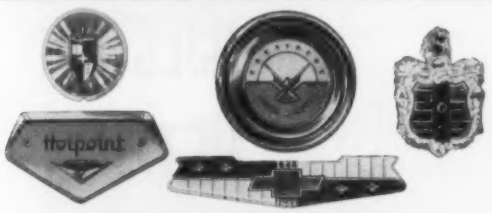
THREE DIMENSIONAL

REFLECTOR LENSES

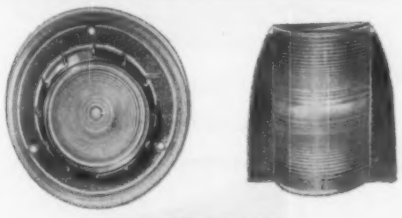
INDUSTRIAL MOLDING



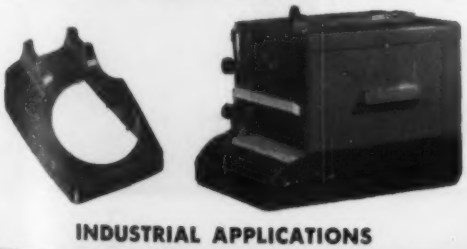
EXTERNAL METALLIZING



THREE DIMENSIONAL PARTS



ERIEFLEX LENSES



INDUSTRIAL APPLICATIONS

ERIE, pioneer in custom molded plastics, has constantly maintained its leadership in the solution of difficult molding problems, in the development of new molding techniques, and in devising methods for increasing the artistic appeal of plastic products.

- **ERIE External Metallizing** gives a metallic luster to plastic, equal in attractiveness to electroplating on metal, but non-tarnishing and lasting, atmospheric resistant. In addition to the usual metal plated effects it may be had in a wide range of gleaming metallic finishes. It offers new possibilities for ornamental functional effects.

- **ERIE Three Dimensional Plastics** in sparkling, colorful, and lasting beauty, grace millions of autos, household appliances, radio and TV sets, and many other products. As identifying emblems or functional parts they are an indication of product quality and add to sales appeal.

- **ERIEFLEX Lenses** for taillights and markers are scientifically designed to concentrate the light in scintillating beams direct to approaching headlights, regardless of the angle of approach. An important safety factor in night driving.

- **ERIE Industrial Moldings** are made by the company with the longest experience in custom injection molding in the field. ERIE has produced parts which other molders said couldn't be made; and has devised economical production methods for parts which by standard procedure were prohibitively expensive.

ERIE *Plastics Division*

ERIE RESISTOR CORPORATION

MAIN OFFICES: ERIE, PA. FACTORIES: ERIE, PA. • HOLLY SPRINGS, MISS.

THIS SYMBOL ON YOUR PRODUCT MEANS

TRANS-MATIC

PLASTICS COMPANY

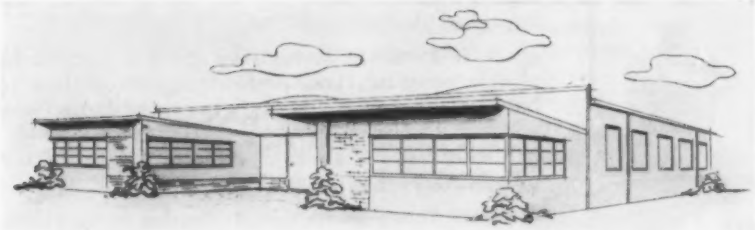
5501 W. MONTROSE AVE., CHICAGO 41, ILL.

HAS MOLDED & FINISHED YOUR PRODUCT WITH CAREFUL ATTENTION TO ALL DETAILS OF YOUR SPECIFICATIONS AT THE LOWEST POSSIBLE COST

CUSTOM MOLDERS OF ALL THERMOSETTING COMPOUNDS — PHENOLICS, MELAMINES, UREAS & ALKYDS

PLUS YEARS OF KNOW HOW & A MODERN TOOL ROOM

Plastics — a 20th Century Product



Have your plastics problems made you "plasthappy"?

Consult our PHD's (Doctors of Plastic Helpology). We specialize in solving impossible problems in designing, molding, finishing and packaging your product—all under one roof in our brand new plant. We have pioneered in the new materials—linear polyethylene—nylon—cycolac—exon—kralastic. We can brighten your Plastic Parts by Plating, Spraying or Stamping. Come in to see us, we're always home.

20th CENTURY PLASTICS COMPANY

4210 N. Sayre Avenue Chicago 34, Illinois Underhill 7-9494

D. D. Butterfield, Jr.

NAUGATUCK, CONNECTICUT

MOLDERS

OF ALL TYPES OF PLASTICS MATERIALS BY

COMPRESSION, TRANSFER AND INJECTION METHODS

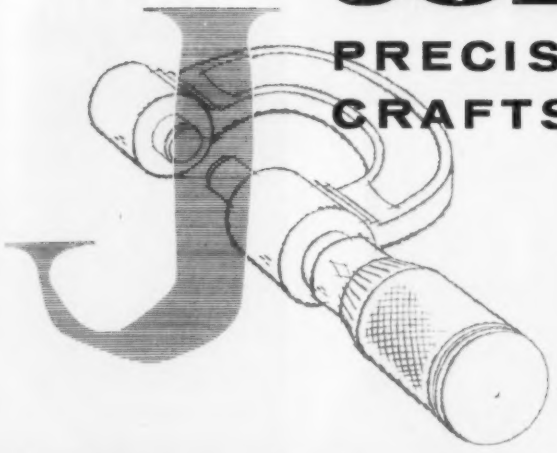
WE INVITE YOUR INQUIRIES

D. D. Butterfield, Jr.

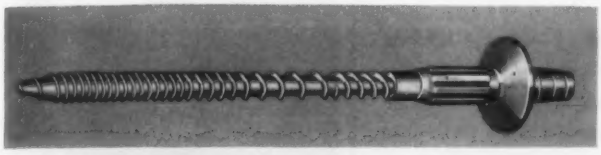
NAUGATUCK, CONNECTICUT

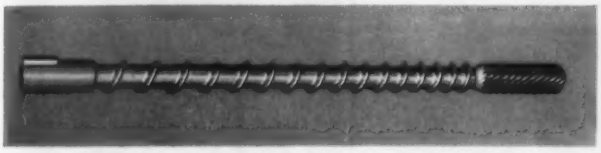
JOHNSON

PRECISION CRAFTSMANSHIP



Safeguards your Quality

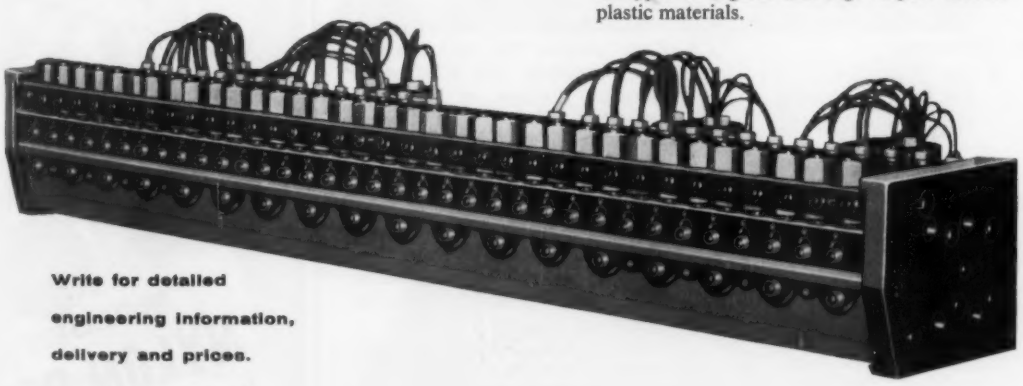




Whatever your requirements may be for extrusion screws . . . variable pitch, multiple lead, increasing root diameters, with stellite or flame-hardened flights, out of any material . . . we can precision machine for you from your prints.

The precision craftsmanship consistently maintained in our plant is your assurance of quality control of your finished products. Let us quote on your requirements.

Johnson Sheeting Dies are made to exacting tolerances unsurpassed in the industry. Standard assembly provides for either thick or thin gauge extrusion; completely wired with Chromalox cartridge heaters. Designed for extruding all types of regular and high impact thermoplastic materials.



Write for detailed engineering information, delivery and prices.

PLASTIC MOLDS, DIES AND SCREWS

JOHNSON MANUFACTURING COMPANY

229 S. MAIN STREET PHONE PARK 3-5222 CHIPPEWA FALLS, WISC.

NOW!

ELECTROMOLD CORP.

Provides...
a NEW method
of Mold-making
and Repairing



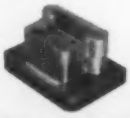
NICOFORM®

. . . the exclusive, patented process that produces the most durable electroformed molds; permits the use of low cost masters in steel, brass, aluminum and plastics. No heat distortion . . . ideal for precision work!



NICOFORM®

. . . can faithfully reproduce artistic designs and decorative components; translates a sculptor's work into hard metal without alteration.



NICOFORM®

Repair Process . . . adds metal without heat, pits, edge marks, etc.; also for repair of almost inaccessible areas; saves machining.

SEND FOR OUR LITERATURE

Investigate the almost limitless possibilities. Ask us to show you sample surface and pattern details never before possible.

ELECTROMOLD CORP.

144 Enterprise Avenue
Trenton, New Jersey

How to figure
your sales potential
in the plastics field



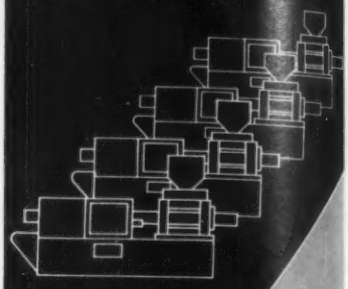
FREE . . . 40-page brochure will help you find answers to your questions about sales opportunities in the fast-growing plastics field.

THIS NEW STUDY contains the inside story of one of America's fastest growing industrial markets. It presents one of the most stimulating and detailed analyses of the plastics field that has yet been published. It's filled with up-to-date figures on the consumption and production of plastics materials, on the field's processing equipment requirements, on potential areas of growth. It lists hundreds of kinds of machines, accessories, chemicals and intermediates, supplies and special services for which the field is manifesting an ever-increasing appetite.

You will find this handsome brochure—file size, lavishly illustrated, 40 pages—a valuable addition to your business library. It may well point the way to increased sales for the industrial products or services that your firm supplies.

For your free copy of "The Plastics Field," simply address a note on your company letterhead to *Advertising Manager*, Modern Plastics, 575 Madison Avenue, New York 22, N.Y.

CUSTOM
INJECTION
MOLDING
of every type



Press capacities
from 4 ounces to
200 ounces

MOLDED
NYLON SLAB
STOCK

MOLDED
NYLON ROD
in a wide range
of stock sizes

Member of Plastics Pioneers

A. L. HYDE CO.
GRENLOCH, N. J.
ESTABLISHED 1932

Sandee

for QUALITY . . .
SERVICE . . .
PRICE . . . in

PLASTIC EXTRUSIONS

Sheets for Vacuum Forming



HI IMPACT STYRENE
LIGHT STABLE STYRENE
ACRYLIC
BUTYRATE
ETHYLCELLULOSE
LINEAR POLYETHELYENE

Sign Faces

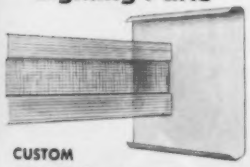


CUSTOM
STANDARD (from stock)

Shapes and Sections for all Industry



Lighting Parts



CUSTOM
STANDARD (from stock)

Sandee
MANUFACTURING COMPANY
5050 Foster Avenue Chicago 30, Illinois

What'll You Have?

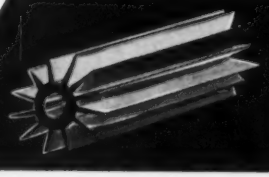
WE'VE GOT IT!—OR WE CAN EXTRUDE IT FOR YOU!

BINDINGS?



We manufacture TOUREX, the famous virgin vinyl binding, that is universally used throughout the luggage and leather goods industries.

BICYCLE PEDAL INSERTS?



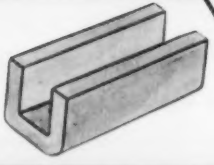
WELTINGS?



VINYL PROFILES FOR ALUMINUM SHAPES?



CHANNELS?

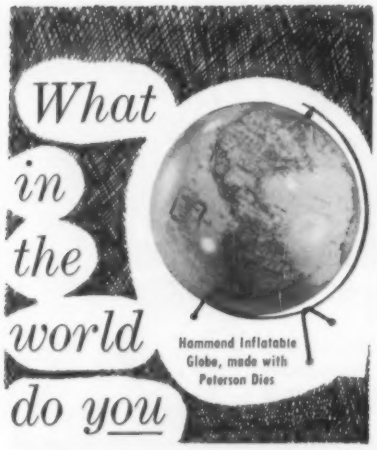


All these and many more shapes are extruded to precise specifications by our skilled technicians and engineers.

If you have a difficult application problem, contact us today and let us show you how to solve it to your complete satisfaction.

Waljohn PLASTICS, INC.

440-88th STREET • BROOKLYN 9, NEW YORK • SHORE ROAD 8-0300



want to make?

Whatever product you want to fabricate from vinyl, let Peterson help you make it better... at less cost with the right dies and other equipment for the job.

Throughout the plastics industry, Peterson is the name for quality Electronic Sealing Dies, Automatic Devices, Automatic Indexing and Feeding Equipment.

WE WORK FROM YOUR BLUEPRINTS ...OR FROM YOUR IDEAS

All Peterson needs to know is the problem... and we can create the equipment you need to do the job you want. That's why the biggest names ...and the smallest... in the vinyl fabrication field call on Peterson for engineering and design help as well as equipment manufacture. Why not talk over your die problems with Peterson... today.

Second generation of die makers

A. W. PETERSON & SON DIE COMPANY, INC.
131 PRINCE STREET
NEW YORK, NEW YORK

CUSTOM MOLDING

of

Thermo-Reactive Molding Compounds

for

applications involving

- **HEAT RESISTANCE**
- **IMPACT RESISTANCE**
- **ELECTRIC ARC RESISTANCE**

RESINOID
Thermosetting Plastics
ENGINEERING CORPORATION
3447 HOWARD ST
SKOKIE, ILLINOIS

...PROGRESS

The progress of tomorrow is achieved through the bold imagination... the meticulous planning of today.

Reynolds creative chemistry plays a vital role in bringing solutions to chemical problems of manufacturers throughout the nation.

If you are in doubt about plastisol or organisol applications to your specific needs (coatings, platings or actual production materials) a wire or letter will bring prompt reply to your questions... without obligation, of course.

REYNOLDS CHEMICAL PRODUCTS COMPANY
ANN ARBOR, MICHIGAN

"Division of Stubnitz-Greene Corp."

Looking for

CARMER

KEL-F
ZYTEL
TEFLON

rods, tubes, sheets?

Our distributors maintain full inventory at all times. That's why they're always able to fill orders for single units or for thousands.

- Available in any size.
- Full range of rod and tube diameters.
- Special tolerance control insures exact dimensions ordered.
- In addition to stock sizes, we can extrude to any size you require.

Carmer products are available through our centrally located outlets:

Commercial Plastics & Supply Company
New York, Pittsburgh, Greensboro, Miami

Allied Plastics Supply Corporation
New York

Fluorocarbon Company
Fullerton, California

Delta Products—Division of Air Accessories, Inc.
Houston, Ft. Worth

Plasticrafts, Inc.
Denver

Carmer Industries
22 North 26th Street
Kenilworth, New Jersey

Looking for

CARMER

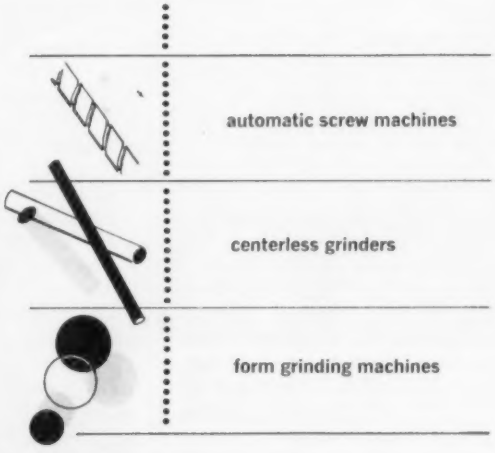
specialty products and services?

Ultra thin wall tubing for packaging—(wall thicknesses from .004" to .006").

Insulator sleeves for resistors, solderless connectors, capacitors, etc.

The Carmer Service Division is set up to handle machine work on every type of plastics material. If you want help in getting your plastics project started, you can count on our engineering and technical people for sound advice.

Equipment includes



Submit your blueprints or specifications for our quotation.
Write for new brochure and price lists.

Carmer Industries
22 North 26th Street
Kenilworth, New Jersey

812C

Important Facts About the $12 Billion Packaging Market . . .

PRACTICALLY ALL PRODUCTS are packaged. It's almost easier to count the industries that *don't* package than those which *do*. That's why the packaging market is horizontal . . . includes the thousands of companies that make products of all kinds that are packaged for shipment or sale.

Packaging is, in fact, so integral a part of business as a whole that it expands as business expands. In 1954, according to the U. S. Department of Commerce, the value of materials, supplies and services used in packaging the nation's output stood somewhere between 12 and 15 billion dollars. And as the national output of goods increases each year, so does the demand for packaging, packaging equipment and related supplies.

What the Market Uses . . . and Buys

The range of America's products are as wide as our ingenuity. And the variety of containers is equally broad. Depending on the nature of the product, its package can be a bag, barrel, bottle, box, can, carton, chest, crate, capsule, drum, envelope, jar, tube, vial or wrapper.

Often a package will be a composite of several of these forms and will use many materials: adhesives, coatings, cork, fabric, film, foil, glass, ink, wood, paper, plastics, tape, and wax.

To make these containers—and fill them—takes bag machines, bottling equipment, box machines, capping equipment, cartoners, conveyors, counters, die-cutters, filling machines, labelers, printing presses, scales, slitters, staplers, stitchers, unscramblers and vibrators. And they may also require such additional services as embossing, fabricating, laminating, plastic molding, and contract packaging.

All of these containers, materials, supplies, services and machines are part and parcel of "packaging." They're the factors that give the market its tremendous scope.

Who Does the Buying

The factors that control package selection are as complex as business itself. They include production, quality control, shipping, display, advertising, sales, promotion . . . and, often, outside packaging consultants. The purchase and specifications of packaging materials usually cuts across many departments of a company.

Because the buying influences are so diverse, it is difficult for salesmen to reach them all. Most suppliers, therefore, rely heavily on advertising to carry a good share of their selling lead.

How Modern Packaging Fits In

MODERN PACKAGING is the oldest and largest magazine serving the packaging field. Prior to its founding in September, 1927, the concept of packaging as a common function of many industries was not generally recognized, nor was it realized that these industries have common packaging objectives, techniques, problems and procurement needs.

MODERN PACKAGING changed all that. It gave the users of packaging everywhere a single reliable forum where mutual problems might be solved and where new packaging materials, methods and services could be publicized. As a result it gave packaging suppliers a *single* medium through which they could reach the various buying influences in the many industries that package the great bulk of the nation's goods.

Paid Circulation is Essential

Because of the intricate purchasing patterns involved in the selection and specification of package designs, materials and equipment, it's just not possible to select "packaging men" simply on the basis of job titles.

For this reason MODERN PACKAGING's policy of *paid circulation* is vitally important to advertisers. It is insurance that subscribers are directly and intimately concerned with packaging operations, because packaging men identify themselves and their interests by laying hard cash on the line.

Since the magazine's founding in 1927, its paid circulation has risen steadily—from 2,500 to its current all-time high of 20,600 out of a total print order of 24,500. The bulk of the remaining copies are used to provide additional rotating distribution for conversion into paid subscriptions.

Editorial Content

The editorial purpose of MODERN PACKAGING is to keep packagers informed of all the significant advances in the methods, materials and equipment of the art. Editorial feature space is devoted to carefully researched original articles. About 90% is staff written, 10% contributed by authorities in the field. Through the use of analyses, illustrations, case histories and "how-to-do-it" articles, the editors point out and interpret packaging trends.

Advertising Acceptance

Year after year, *more* advertisers invest *more* money in *more* space in MODERN PACKAGING than in *all other packaging publications* combined. And, last year, they set new all-time highs in both *space* and *dollar volume!*

Get More Facts

To learn more about the sales potentials in the packaging field for the products *you* make, just write to *Advertising Manager,* MODERN PACKAGING, 575 Madison Avenue, New York 22, N. Y.

* * *

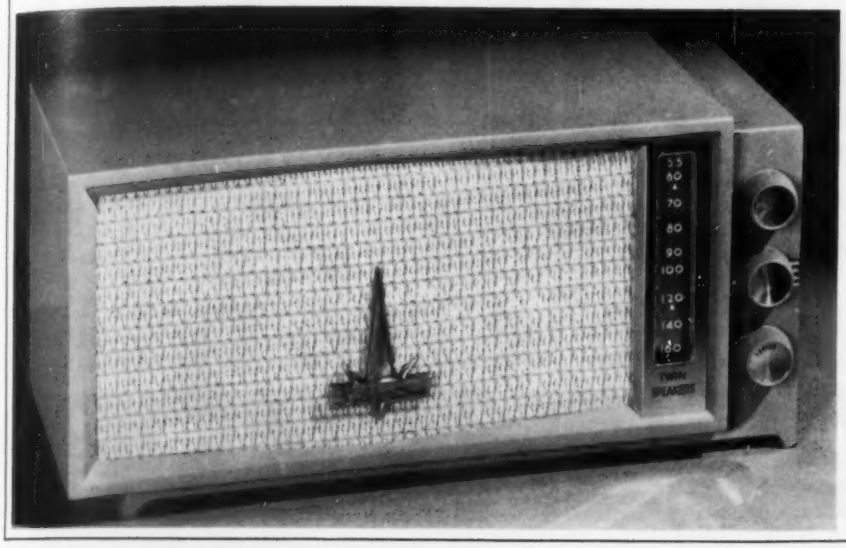
MODERN PACKAGING MAGAZINE

A BRESKIN PUBLICATION

812D

Whether it's RADIO CABINETS OR TELEPHONE HOUSINGS—REFRIGERATION OR AUTOMOTIVE PARTS...

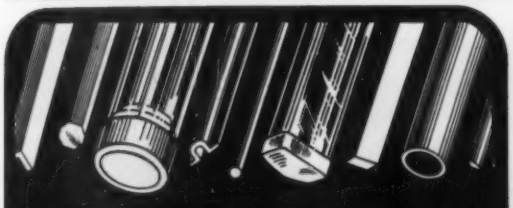
COMO is your answer for precision molded parts and finishing



The housing of this attractive radio is one of the many examples of COMO... fine molding... development... engineering.

COMO'S modern plant equipment can handle every stage of manufacturing from design to mass production.

COMO
PLASTICS, INC.
COLUMBUS, INDIANA



special SHAPES

THIN WALL TUBING — ANGLES — CHANNELS
MOULDINGS — RODS — INTRICATE PROFILES
STRIPS — TRANSPARENT CONTAINERS

Custom Extruded to your specifications in most thermoplastics
ECONOMICALLY·ACCURATELY·QUICKLY.
Compounded, Designed, and Colored—Matched to your specs.

*PLASPAK Transparent Containers in most thermoplastics for Toothbrushes, Hardware, Cosmetics, Bait & Tackle etc., made to your specifications in diameters ranging from ½" OD to 2" OD.

Submit your blueprints or suggested designs for our quotations.

PLAS-TUBE CORPORATION
26 Fahey St., Springdale, Connecticut
Fireside 8-5746



new economies in **NYLON GEARS** means savings in gear costs up to 90%

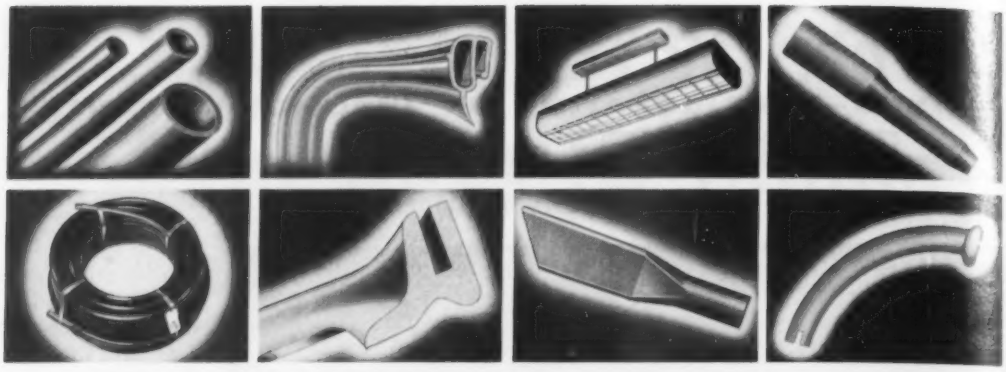
Our many years of successful production of Nylon Gears can now make even greater economies for you. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication — they mate perfectly with metal gears.

Let our engineers with more than a decade in gear experience consider your gear problems DURING the design process — send blueprints or specs for prompt estimates.

Gears made only to your specifications. None carried in stock.

106

PROCESS GEAR CO., INC.
4612 W. Fullerton • Chicago 39 Illinois



CUSTOM PLASTIC EXTRUSIONS for every purpose

Turn to Yardley for high precision and absolute uniformity in plastic tubing, extruded gaskets, plastic shapes and other forms of plastic extrusions.

Consult us on your specific requirements in either standard or special shapes in all top-quality thermoplastic materials. Quick deliveries in any production quantities.

YARDLEY PLASTICS CO.

Parsons and Town Streets • Columbus 15, Ohio

WRITE FOR BULLETIN NO. 150

In Canada: Daymond Col, Ltd., Chatham, Ont.
Export Sales: F. & J. Meyer, 115 Broad Street, New York 4, U.S.A.



HMS associates

Product Design for Plastics

1923 Fairview Ave.
Willow Grove, Pa.

Specialists in . . .
design and development for injection molding

Model Making

Consultants

The Fastest Growing Name In Custom-Molding

FACILITIES		SPECIALISTS IN:
Compression		Glass-filled Melamine
Injection		Diallyl-phthalate
Transfer		Kel-F
Complete Assemblies		Acetate
		Nylon
Products Pictured (top to bottom) Spool, Terminal Board, Feed-Through Insulator, Electrical Cap		Glass-filled Polyester-alkyds

Write for new facilities brochure

PENN-PLASTICS CORPORATION
Glenside, Pennsylvania

IN PRECISION PLASTIC MOLDING VICTORY Does The Job COMPLETE!

We mold Refrigerator Parts; Radio Parts, Escutcheons, Cabinets; Automobile Parts; Decorative Trim; Knobs, Handles; Toys, Novelties; Houseware Items; Premium Goods; Camera Cases; Many Other Items.

Put Victory's *complete* facilities to work for you . . .

- ENGINEERING—Victory's staff of engineers includes specialists in the mechanical, electrical and chemical fields.
- MOLD MAKING—Victory's complete and modern tool room is supervised by men with over 30 years' "Know-How" specializing in injection molds.
- INJECTION MOLDING—Victory's ultra-modern, high-speed equipment, newly expanded production facilities, and competent use of controlled molding techniques assure top quality.
- ASSEMBLY—Victory's conveyor line operation guarantees top speed and economy on plastics as well as the most complex electro-mechanical assemblies.
- FINISHING—Victory's up-to-date automatic paint spraying, hot stamping and silk screening equipment gives you custom-finish jobs at production line prices.
- ATTENTION: SALES ORGANIZATIONS—Victory will manufacture and package your product, individually and in multiple-unit cases, preparing it for immediate shipment to your customers.

"All operations under one roof" saves you time, effort and money. Let us help you with your thinking. Contact us NOW!



Examples of Victory's Precision Plastic Molding

VICTORY MANUFACTURING CORP.
VICTORY — CHICAGO

1726 West Arcade Place • Chicago 12, Illinois
HAymarket 1-7584 ESTABLISHED IN 1930
Member: Society of the Plastics Industry
19 PRESSES 2 TO 60 OUNCES

BETTER PRODUCTS ARE MADE WITH
BETTER DIES
Designed by Western



DIES FOR PUNCHING • CUTTING • TRIMMING • SCORING • EMBOSSING • HEAT SEALING AND PERFORATING FUNCTIONS

. . . many of them in one operation

Send us a sample, blueprint or sketch of your die needs. No die is too large . . . too small . . . or, too intricate for Western's experienced craftsmen to produce.



DO IT RIGHT . . . DIE IT *Western!*

WESTERN SUPPLIES CO.
2918 CASS AVE., ST. LOUIS 6, MO.

cPc

- **TUBING** Saran • Polyethylene • Vinyl
- **PIPE** Kralastic • Saran • Polyethylene
- **FITTINGS** TUBING & PIPE
- **CLAMPS** Saran • Nylon • Polyethylene Ethocel
- **CUSTOM** MOULDING & EXTRUSION

PIONEERS in development of Saran Tubing and Fittings . . . pioneers and **ORIGINAL MFRS.** of **CLAMPS** for wiring, tubing, etc. The House of Commercial offers you the advantages of years in leadership and experience.

WRITE FOR

Catalog • Samples • Prices

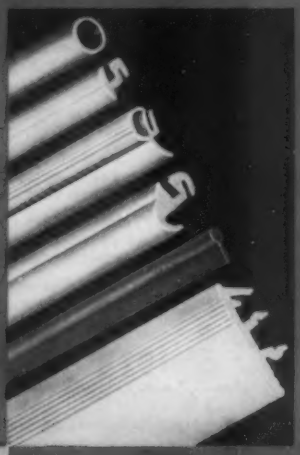
100's of items in our IN STOCK dept.

941 GEORGE ST. CHICAGO 14
COMMERCIAL PLASTICS CO.

MACOID

Complete Plastics Service

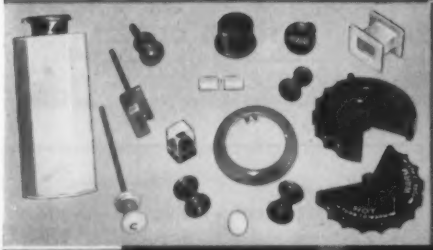
- DESIGNING
- ENGINEERING
- PRODUCTION



EXTRUSIONS

ROD, TUBING, and PROFILES

MACOID engineers are specialists in the extrusion of plastics. They are the men who originated the dry process for plastic extrusions.



INJECTION MOULDINGS

MACOID is also a pioneer injection molder of plastics. We supply many industries with a steady flow of products.



PRODUCTION FACILITIES—MACOID designed the molds, molded the parts, painted where necessary, and assembled these perfect miniature Hudson cars.

CONSULT MACOID when you are in the planning stage of a new part or product—or when you are about to redesign an old one. THERE IS NO OBLIGATION.

Originators of Dry Process Plastics Extrusion

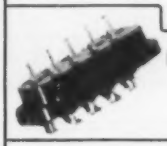
DETROIT MACOID CORPORATION

Extrusion and Injection Molding • 12340 CLOVERDALE, DETROIT 4, MICH.

CUSTOM MOLDERS of PLASTICS *for Industry*

ELECTRICAL SWITCHGEAR COMPONENTS





ELECTRONIC & RADIO COMPONENTS

INSTRUMENT HOUSINGS





GROUND WOOD MOLDING

APPLICATIONS REQUIRING SPECIAL THERMOSETTING MATERIALS

- *SILICONE MATERIALS*
- *FOR X-RAY OPACITY*
- *GLASS FILLED*
- *NITRILE RUBBER FILLED*
- *ORLON FILLED*

Write or phone for illustrated brochure describing our extensive molding and finishing facilities.

INSULATION MFG. COMPANY, Inc.

11 New York Avenue
Brooklyn 16, N. Y.
NEvins 8-6633

Advertisers' Index

FABRICATING & FINISHING

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 818.

CLEANING & POLISHING COMPOUNDS
Schwartz Chemical Co., Inc. 847

COATINGS
Logo, Inc. 858
Schwartz Chemical Co., Inc. 847
Sullivan Chemicals, Div. Sullivan Varnish Co. 852

CUSTOM FABRICATORS
Ace Plastic Company 857
Carroll, J. B., Company 842
Hopp Plastics, Div. The Hopp Press..... 856
Plastic Stamping & Molding Corp. 852
Sillcocks-Miller Company, The 846

DECORATING & FINISHING TOOLS & EQUIPMENT
Ackerman-Gould Company 863
Apex Machine Company 862
Conforming Matrix Corporation 853
Finish Engineering Co., Inc. 862
Fiore, Wm. M., Inc. 843
Gane Brothers & Lane, Inc. 861
Kramer, H. W., Co. 852
Lupoline Automatic Polishing Equipment Corporation 857
Matthews, Jas. H., & Co. 858
Nash, J. M., Company 845
Thierica Studio, Sepanski and Associates 860
Tumb-L-Matic, Inc. 855

DECORATORS
Carroll, J. B., Company 842
G. M. C. Process Corporation 857
Hopp Plastics, Div. The Hopp Press 856
Peerless Roll Leaf Company, Inc. 855
Sillcocks-Miller Company, The 846

DIE CUTTERS
Carroll, J. B., Company 842

FASTENERS
Parker-Kalon Division, General American Transportation Corporation 848, 849

FINISHING COMPOUNDS
Lupoline Automatic Polishing Equipment Corporation 857

HEAT SEALING EQUIPMENT
Cosom Engineering Corp. 854

HINGES
Geissel Mfg. Co., Inc. 863

MARKING AND PRINTING EQUIPMENT
Ackerman-Gould Company 863
Acromark Company, The 840
Apex Machine Company 862
Conforming Matrix Corporation 853
Cosom Engineering Corp. 854
Gane Brothers & Lane, Inc. 861
Irvin, Jewell & Vinson Co., The 863
Kingsley Stamping Machine Co. 861
Olsenmark Corporation 841

ROLL LEAF
General Roll Leaf Manufacturing Co. 858
Olsenmark Corporation 841

SAW BLADES
Forrest Manufacturing Company, Inc. 842

SHEETS, RODS, TUBES, BALLS
Ace Plastic Company 857
Colonial Kolonite Co. 844
Orange Products, Inc. 861

TUNGSTEN COILS & STRANDS
Sylvania Electric Products, Inc. 851

VACUUM COATING EQUIPMENT
NRC Equipment Corporation 850

VACUUM FORMERS
Carroll, J. B., Company 842

WELDED FILM & SHEETING
Fabrico Manufacturing Corp. 862

WELDING TORCHES
D & R Plastic Welders, Inc. 850

Fabricating and Finishing

Fabricating and Finishing

IN THIS SECTION

Adhesive Bonding 818
Machining
Thermoplastics 824
Decorating Molded Plastics 828
Metalizing 834
Welding Plastics 838

To assist the user of MODERN PLASTICS ENCYCLOPEDIA in keeping track of advances in the field of fabricating and finishing, a summary on Recent Developments has been included with each of the articles in this section. All the items have been excerpted from the New Machinery and Equipment pages of MODERN PLASTICS, October 1956 through July 1957 issues.

ADHESIVE BONDING

BY IRVING SKEIST*

Pipe, vials, fabricated displays, complex toys, metallic yarn, laminated film for packaging, vinyl-clad metal for luggage—these are only a few of the plastics products for which good adhesive bonds may be required.

Through trial and error, supplemented at long last by the beginnings of a theory, the following set of rules for adhesive bonding of plastics has evolved:

1) The crystalline plastics are best bonded by heat rather than adhesives (i.e., best adhesive is the polymer itself, melted).

2) Amorphous or noncrystalline plastics are bonded to themselves with monomers or cements —either solvent cements, consisting entirely of solvents, or bodied cements, in which resins are dissolved in the solvents to thicken them, thus aiding in filling the spaces between poorly mating surfaces.

3) To bond two different plastics, or a plastic to a nonplastic, it is best to use a polymeric adhesive. For good adhesion of the two surfaces, the initial viscosity of the adhesive must be low; while for good cohesion within the adhesive layer, its final viscosity must be high. The viscosity change is accomplished by evaporation of solvents from cements, evaporation of water from latices, polymerization of monomers, or curing of resin intermediates.

4) To minimize strains (and resulting stresses) caused by flexing or temperature change, the adhesive layer should be as thin as possible, and no more rigid than the materials being joined (the adherends).

5) Solvents and polymers for adhesives should be selected to correspond to the adherends in solubility parameter. This may require the use of a two-layer adhesive if there is a big difference between the solubility parameters of the two adherends being used.

6) Low-boiling solvents give the fastest setting action, but are more likely to cause crazing. Crazing is most likely to occur with the more brittle plastics (polystyrene worst, acrylics somewhat better). To minimize crazing, avoid low-boiling solvents, or dilute them if used.

7) Plasticizer migration is sometimes a problem when two different plastics, at least one of which is plasticized, are brought

* Consultant; director, Skeist Laboratories, 89 Lincoln Rd., Newark 5, N.J.

Recent Developments and References were prepared by the editors.

together. Among the remedies are: a) use of nonmigrating plasticizers, b) harder formulation of the plasticized material, c) use of plasticizers incompatible with the other plastic. The solubility parameter may aid in choosing plasticizers for a particular application.

Crystallinity and solubility parameter

These are the rules as of today. The first step in using them is to classify the materials according to ease of solubility (or noncrystallinity) and type of solvent (or solubility parameter).

In Fig. 1, p. 820, the highly crystalline, difficult - to - dissolve plastics such as 6/6 nylon, polyethylene, and Teflon[1] are at the right, while the amorphous, easily dissolved plastics such as polystyrene and polymethyl methacrylate are on the left.

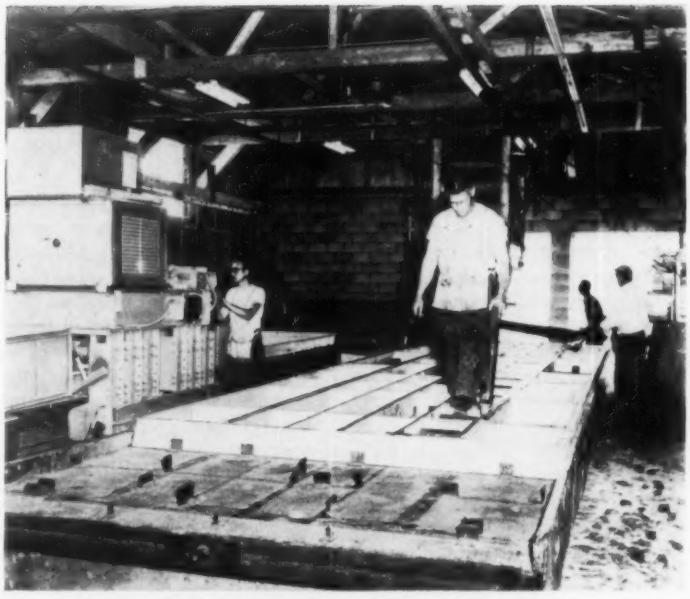
The crystalline plastics are most readily bonded by heating them to a high enough temperature to destroy the crystallinity, then compositing with pressure while hot.

The noncrystalline and moderately crystalline plastics are more commonly bonded with adhesives which are liquid at the time of application but which lend themselves to the formation of a flexible solid interlayer through evaporation of volatiles or curing of a resin intermediate.

Vinyls and cellulosics are fairly crystalline and are difficultly soluble in the unplasticized state. But with the addition of plasticizer (nonvolatile solvent), they become more amorphous and consequently more amenable to adhesive bonding by volatile solvents. Also, copolymers are more easily bonded than homopolymers.

The adhesive must be chosen with an eye to solubility parameter [SP] (see References at end of article). Reading downward in Fig. 1, p. 820, the more polar plastics like nylon have high SPs while the less polar hydrocarbon and fluorocarbon plastics have low SPs. Each plastic material dissolves best in solvents whose SPs are about equal to its own. This is the modern version of the old cliché, "like dissolves like."

[1] Trademark of E. I. du Pont de Nemours & Co., Inc.



Urea formaldehyde adhesive is rolled onto the wooden frame of a trailer. Because of adhesive's strength, no nails are needed. (Photo, American Cyanamid)

Table I, p. 823, gives the solubility parameters of some of the more common solvents. There are many exceptions; but by matching this table against the chart, it is usually possible to select those solvents "most likely to succeed" for a particular plastic.

Crazing

Crazing is a problem of the more brittle plastics. If plastics are ranked according to area under the stress-strain curve, it is found that polystyrene requires the least energy to break it. That is, polystyrene is the most brittle. Next among the more common thermoplastics are the acrylics, then the vinyls and cellulosics, and finally the tough nylons.

For styrene and acrylics particularly, the choice of solvent poses a problem. The low-boiling solvents attack the plastic surfaces most quickly, permitting fastest assembly. But low-boilers also evaporate from the cemented piece most readily, leaving the joint in a state of stress which may be detrimentally relieved by crazing—the formation of many tiny cracks. Methylene chloride, highly volatile, softens polystyrene or acrylics quickly; but the polystyrene bond will craze in less than a month. Even without bonding, an injection molded piece may be sufficiently strained at the surface to craze when exposed to too active a solvent. Annealing at slightly below the softening temperature is of some help with acrylics, less effective with polystyrene.

High-boiling solvents and nonvolatile plasticizers, while slower to take hold, are safer. Perchloroethylene has been recommended for acrylics, amyl benzene for styrene. A low percentage of methylene chloride is permissible for quick starting.

Cements

Many different "cements" are used in bonding plastics. A cement may contain some resin or it may be simply a mixture of solvents. In resin-bodied cements, a single solvent is almost never used. A mixture of low- and high-boiling solvents is preferred to control the evaporation rate. If evaporation proceeds too quickly, crazing, blushing, and poor adhesion may result. If it proceeds too slowly, the cement takes too long to set.

The resin manufacturers sug-

gest the following compositions, among others, for bonding thermoplastics to themselves:

Polystyrene: Toluene, perchloroethylene, xylene, or amyl benzene, diluted cautiously with methylene chloride for speed, and bodied with 10 to 15% polystyrene if necessary.

Acrylics: Softer formulations are bonded with trichloroethane, harder acrylics with 90/10 methylene chloride/diacetone alcohol. For maximum joint strength and good weathering, it is best to soak the surfaces to be bonded in a 60/40 methylene chloride/methyl methacrylate monomer mixture which has been catalyzed by 0.2% benzoyl peroxide to cause the monomer to polymerize. Again, the cement should be bodied with a few percent polymethyl methacrylate if the surfaces are irregular, or if the acrylic plastic is to be bonded to acrylic-impregnated fabrics, as in aircraft canopy construction.

Cellulosics: Solvent cements are generally mixtures of fast driers such as acetone and slower drying materials such as methyl Cellosolve or methyl Cellosolve acetate, or even nonvolatile plasticizers. For cellulose acetate a 70/30 acetone/ethyl lactate mixture is suggested; some of the acetone may be replaced by ethyl acetate. For cellulose acetate butyrate and propionate, a 70/30 acetone/methyl Cellosolve acetate mixture is effective. The cements may be bodied with cellulose esters, or with the more strongly adhesive cellulose nitrate if the cellulose ester plastic is to be bonded to a different material.

Vinyls: The following formulations are suggested for the bonding of rigid vinyl sheet to itself. Both are based on methyl ethyl ketone (MEK), plus a small amount of acetic acid for better "bite." The first contains a small amount of high-boiler and nonvolatile plasticizer, while the second cement is bodied with a ketone-soluble vinyl chloride-acetate copolymer.

Solvent cement: 63% MEK, 20% dioxane, 10% methanol, 2.5% dioctyl phthalate, 2.5% isophorone, 2% acetic acid.

Bodied cement: 96% MEK, 2% VYNS resin, and 2% acetic acid;

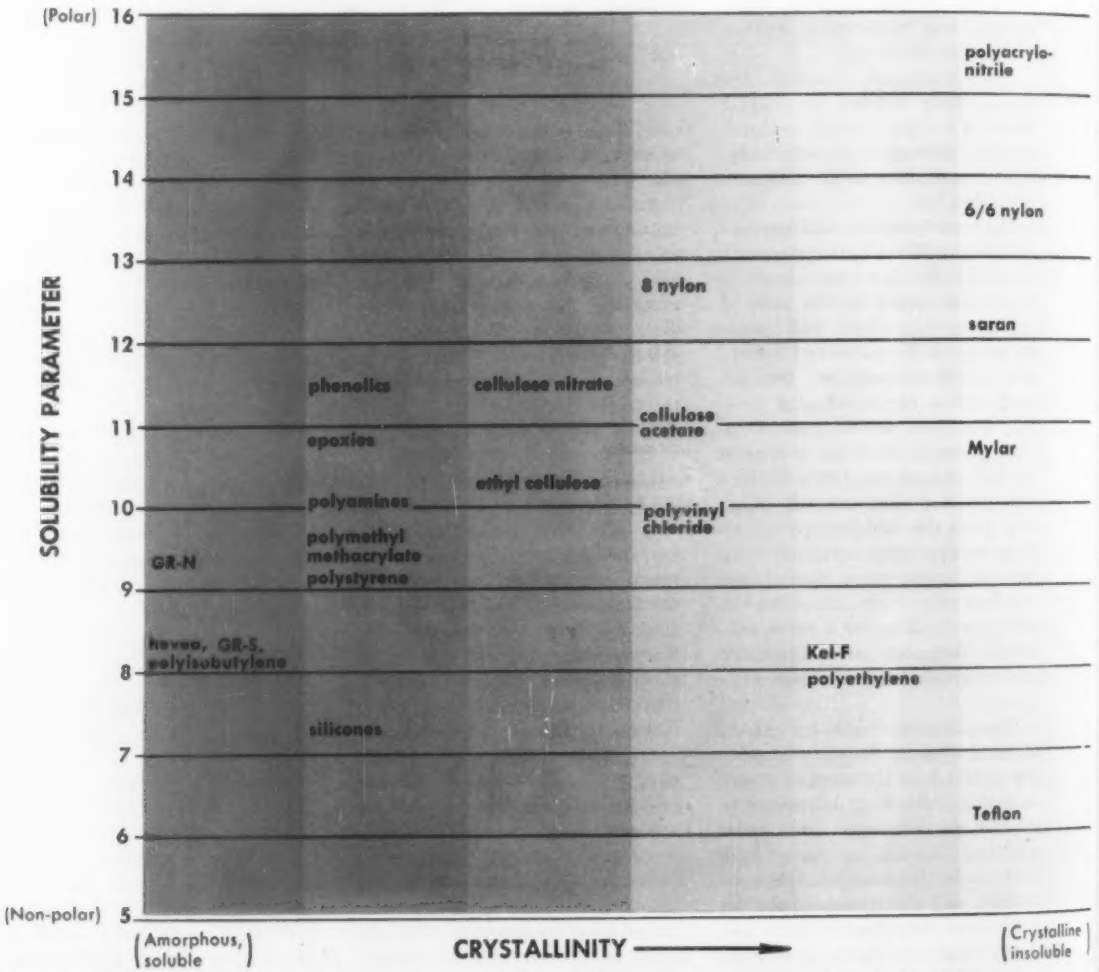


Fig. 1: Crystallinity-polarity map for the common polymers and elastomers. Crystallinity ranges from almost none at the left to half or more at the right. The more crystalline polymers are harder to dissolve, some only dissolving in hot solvents. Solubility parameter constitutes a guide to choosing an effective solvent

An epoxy adhesive kit (*Hysol Epoxy Adhesive Kit*, Houghton Labs., Inc.) contains two tubes, one of resin and the other of hardener. It is measured by squeezing equal lengths of bead of hardener and resin on a mixing surface, then mixing with a spatula. This eliminates the need for batch weighing or metering equipment. The mixed compound has a working life of 30 to 40 minutes.

A high-temperature epoxy-phenolic adhesive (*HT-424*, Bloomingdale Rubber Co.) is available as a supported film and as a liquid adhesive at 90% solids. It produces high strength in large-area metal-to-metal bonds.

A low-viscosity epoxide adhesive (*Eccobond 55*, Emerson & Cuming, Inc.) for joining metal, glass, ceramics, and plastics, and for crack filling can be cured at room temperature.

A modified urea formaldehyde resin liquid adhesive (*Formica Urea 185*, Formica Corp.) is formulated to give craze-resistant glue lines up to 0.02 in. thick. This material may be cold- or hot-set at temperatures from 70 to 180° F. It can be used with hydraulic presses, screw-type presses, or hand clamps. This adhesive provides highly moisture-resistant bonds meeting the requirements of Federal Specification CG-496, Type III.

A pressure-sensitive film adhesive (*Tackmaster*, Rubber and Asbestos Corp.) is a formulated polyvinyl ether composition with outstanding retention of original adhesion values even after prolonged exposure to heat, oxidation, and light. The adhesive film is sold in roll form with a release paper on one side.

A fast-setting contact adhesive (*Hybond 56*, Pierce & Stevens Chemical Corp.) is recommended for most types of dissimilar lamination involving plastics laminates, fiberboards, leathers, wood, etc. The adhesive is said to produce an odorless, nonstaining bond with high dead-load strength but sufficient elasticity to resist shock and fatigues.

A new water-base adhesive (*Chemigum Latex Based Adhesive*, Bond Adhesives Co.), which permits lamination and assembly of certain diverse materials previously not practical, has butadiene - acrylonitrile copolymer (*Chemigum Latex*, Goodyear Chemical Div.) as its chief ingredient. It is a nonflammable-type adhesive with exceptional resistance to humidity. Clarity and flexibility are other characteristics of the material. This adhesive is efficient for bonding polyurethane foam.

Two adhesive products (Compo Chemical Co.) are expected to stimulate the prefinished metal markets. One, a primer, is said to improve plastisol- and organosol-metal bonds which permit all tooling operations. The other, a cement, adheres semirigid vinyl to a wide range of metal and other materials; it is claimed that the resulting bonds can be broken only by tearing the vinyl. The laminate can be deep-drawn, punched, cut, drilled, or crimped with no separation of the plies.

A new contact adhesive (*C-9199*, Pierce & Stevens Chemical Corp.), an elastomeric compound of modified neoprene base, permanently bonds decorative laminates, honeycomb paper, metals, and wood. Bonds are odorless, nonstaining, and resistant to heat, moisture, oil, grease, and many chemicals.

Three new adhesives (National Adhesives Div., National Starch Products, Inc.) for laminating may be applied by reverse roll or gravure methods. A rubber-based adhesive (*Resyn 36-6254*) is designed for laminating cellulose acetate butyrate to foil in the production of metallic yarn. A vinyl lacquer adhesive (*Resyn 76-3930*) is intended for laminating reverse-printed cellulose acetate to foil used in "boilable" flexible containers. The third adhesive (*Resyn 76-3944*) is for laminating polyester film (Mylar) to metalized polyester film, or polyester film to foil.

A new adhesive (*Resyn 76-3963*, National Adhesive Div., National Starch Products, Inc.) will bond rubber hydrochloride (Pliofilm), saran, and polystyrene to foil, rubber hydrochloride to saran, and polyester film (Mylar) to rubber hydrochloride or saran. The synthetic rubber cement contains approximately 33% solids and may be thinned with toluene, or mixtures of toluene with methyl ethyl ketone or ethyl acetate.

Pressure-sensitive transfer film (*Double-Face*, Angier Adhesives Div., Interchemical Corp.) for instant adhesion is adaptable to a variety of porous and nonporous materials and conforms with ease to highly irregular surfaces. The pliable film, incorporating a special tissue reinforcement, is supported by a double-coated release paper which can be removed at once for instant bonding, or at a later date by the consumer. The film is suggested as a substitute for liquid adhesives as well as for mechanical fastenings.

Three resin-base, multi-purpose adhesives (*Tygobond 40, 41*, and *45*, U.S. Stoneware Co., Adhesive Div. 1) have been developed to bond vinyl foam and sponge to themselves or to vinyl fabrics, metal, wood, or composition bases. These air-drying, fast-tack type adhesives are crystal clear and nonstaining. One (*Tygobond 40*) is for spray applications; the others are easily applied by brush or machine coating.

A new line of industrial adhesives (*Ray-Bond*, Raybestos-Manhattan, Inc.), including both thermosetting and thermoplastic compounds, can be used for bonding, coating, or sealing plastics, wood, metal, glass, ceramics, friction material compounds, leather, paper, insulation materials, rubber, and cork.



Three-layer packets for food, cosmetics, drug products, etc. are laminated with bodied cement. (Photo, Celanese Corp. of America)

the strength develops as the solvent evaporates over a number of hours.

Bonding of dissimilar plastics

Adhesive bonding is often the only practical method of bonding dissimilar plastics, but the bond is usually weaker than that obtainable by bonding together two separate pieces of the same type of material.

The main obstacles to be overcome are the difference in solubility parameter, and plasticizer migration. To take care of SP differences, the adhesive should cover a wide SP range. This means it should be one of the amorphous materials at the left in Fig. 1, p. 820. Nitrocellulose dopes are effective for cementing together cellulose acetate and cellulose acetate butyrate. Buna-N rubber, the butadiene-acrylonitrile copolymer, sometimes blended with vinyl chloride copolymer, is utilized for bonding the vinyls.

Plasticizer migration may occur when one of the adherends is a plasticized vinyl or a cellulosic. It may cause crazing when the other adherend is polystyrene or polymethyl methacrylate. The most obvious remedy is to use a harder formula of the plasticized component. Sometimes it is feasible to switch to a closely related material which requires less plasticizer: from PVC to the chloride/acetate copolymer, or from cellulose acetate to either cellulose propionate or cellulose acetate butyrate.

In vinyls, the higher-molecular-weight, straight-chain polymeric plasticizers are nonmigrating. The preferred plasticizers for both vinyls and cellulosics, when they are to be in contact with polystyrene or acrylics, will be those having the higher SPs since they are less likely to emigrate to the lower SP resins.

Bonding thermosets

The thermoset resins are inherently good adhesives in their intermediate, partially cured, still-plastic condition. When fully cured, they are resistant to solvents and cannot be bonded by solvent cements. Generally, they can be bonded by more of the same: phenolics by phenolics, etc. But the epoxy resins will bond phenolics or polyesters to themselves even more strongly than the phenolics or polyesters themselves. In the case of glass-reinforced polyesters, the superior adhesion of epoxy resins to glass is an additional reason for employing adhesives based on epoxy resins.

In addition to epoxies, alloys of phenolic with Buna-N, or phenolic with polyvinyl butyral, are effective for bonding phenolics to themselves as well as other materials. The alloys are softer, better able to resist stresses than straight phenolic.

Plastics to other materials

Plastics are often bonded to metals, glass, paper, cloth—polar materials with high solubility

Synthetic resins facilitate the bonding together of separately molded styrene parts for housewares items. (Photo, Dow Chemical Co.)



TABLE I: Solubility parameters (SP) of solvents and resins (S=soluble)

Solvent	*Drying rate*	*SP of solvent*	*Polystyrene (SP=9.1)*	*Polymethyl methacrylate (SP=9.5)*	*Vinyl chloride polymers (SP=9.7)*	*Cellulose acetate (SP=10.9)*
Ether	fast	7.4				
Amyl benzene (1-phenylpentane)	slow	8.5	S			
Xylene	medium	8.8	S			
Toluene	medium	8.9	S			
Ethyl acetate	fast	9.1	S	S		S
Ethyl methyl ketone (2-butanone)	fast	9.3	S	S	S	S
Trichloroethylene (1,2,2-trichloroethene)	fast	9.3	S	S		
Perchloroethylene (1,1,2,2-tetrachloroethene)	medium	9.4	S	S		
Methyl acetate	fast	9.6				S
Dichloromethane	fast	9.7	S	S		S
1,2-dichloroethane	fast	9.8		S		
Dioxane	medium	9.8			S	
Cyclohexanone	medium	9.9			S	S
Cellosolve	medium	9.9				
Acetone	fast	10.0				S
Isopropyl alcohol	medium	11.5				
Dimethylformamide	medium	12.1		S	S	S
Nitromethane	fast	12.7				S
Ethyl alcohol	fast	12.7				
Water	medium	23.4				

parameters. Fortunately, many polymeric adhesives are available which contain hydroxyl groups or other high-SP groups capable of adhering to these polar surfaces. Among them are proteins, starches and dextrins, gums, polyvinyl alcohol (actually a copolymer with acetate), polyvinyl butyral, cellulose nitrate, vinyl chloride copolymers with maleic anhydride, amino resins, phenolics, epoxies, and others. Those that are most diverse in makeup, such as the epoxies and polyvinyl butyral, are most likely to succeed in bonding plastics to nonplastics.

Composite adhesives, in which metal is primed with a phenolic, for example, and then coated with vinyl, are in use both here and in England.

In thin laminates, bond strength is less important than flexibility and ease of application. Envelopes for drugs, coffee, etc., can be made of adhesive-bonded laminated film. The outer layer of the envelope, reverse-printed on the inside surface, is cellulose acetate. Laminated to the acetate is a layer of 0.0007-in. aluminum foil. Bonding may be accomplished with vinyl acetate or chloride copolymers, cellulose nitrate, or Buna-N rubber, in a mixture of solvents of marginal solubility parameter for cellulose acetate, e.g., toluene and isopropyl acetate. Inside, the foil is thinly coated with vinyl for heat-sealing. The package is strong, attractive, and impermeable to water, oil, and gases.

Adhesive layer requirements

Aside from covering the solubility span, the adhesive layer must fulfil certain rheological requirements.

When applied, it must have a low viscosity in order to spread and to wet and adhere to the surfaces. But for good cohesion in the cemented part, the adhesive layer must soon increase in viscosity or even be cross-linked. Several routes are available to reach these conflicting demands on viscosity. These are outlined as follows:

1) Solutions (dopes, cements) of polymer in organic solvents. These give good bonding; and the characteristics of the final bond, after all solvent has been removed, are predetermined by the known properties of the polymer base. Unless at least one of the adherends is porous, all the solvent must be evaporated after the adhesive is spread on and before the surfaces to be bonded are joined together, since negligible solvent will be absorbed by the adherends. In such cases tackifiers may have to be added to the cement to get good adhesion of the evaporated coated surfaces, and there is the possibility that they may reduce the unit strength of the finished bond.

2) Polymer latices. These are suspensions of polymers or elastomers in water. They are often the cheapest and most convenient to use, but the bond is not as strong as that yielded by other methods. As with cements, if both adherends are impervious to water, the water must be completely evaporated before the surfaces are pressed together.

3) Polymerizable monomers, such as methyl methacrylate. These are slower-setting than the other materials, but have the advantage that no volatile substance needs to be removed from them in the manufacturing process.

4) Curable-resin intermediates, such as urea formaldehyde, phenol formaldehyde, melamine formaldehyde, epoxy, isocyanate,

unsaturated polyester. This is the fastest-growing group, especially the epoxies, because of their adaptability to a wide variety of applications.

There will always be strain when an adhesive-bonded sandwich is flexed or subjected to temperature change. If the coefficient of thermal expansion of the adhesive is markedly different from that of the adherends, heating and cooling will cause shear stresses at the interfaces. If the adhesive is stiffer than the adherends, stresses will accumulate at the interfaces upon flexing, and failure may result. For this reason, the adhesive layer should be thin and somewhat less rigid than the adherends.

References

Consult the Subject Index for further information on adhesives. For adhesives manufacturers, see the Directory Index, p. 1018.

Skeist, I., "Choosing adhesives for plastics," MODERN PLASTICS *32*, 121 (May 1956).

Mark, H., "The Chemistry of Large Molecules." 1940. New York: Interscience Publishers, Inc.

Spurlin, H. M., "Polymer solutions," J. Polymer Science *3*, 714 (Oct. 1948).

Hildebrand, J. H., and Scott, R. L., "The Solubility of Nonelectrolytes." 1950. New York: Reinhold Publishing Corp.

Small, P. A., "Some factors affecting the solubility of polymers," J. Applied Chemistry, *3*, 71 (Feb. 1953).

Burrell, H., "Solubility Parameters. . . .," Cincinnati Meeting of the American Chemical Society (April 1955).

Skeist, I., Chemical Week, p. 40 (April 16, 1955).

Doty, P. M., in A. K. Doolittle's "Technology of Solvents and Plasticizers." 1955. New York: John Wiley & Sons, Inc.

Delmonte, J., "Technology of Adhesives." 1947. New York: Reinhold Publishing Corp.

Simonds, H. R., *et al.*, "Handbook of Plastics." 1948. New York: D. Van Nostrand Company, Inc.

Boundy, R. H., and Boyer, R. F., "Styrene, Its Polymers, Copolymers, and Derivatives." 1952. New York: Reinhold Publishing Corporation.

Ruzler, J. E., *et al.*, "Adhesion and Adhesives." 1954. New York: John Wiley & Sons, Inc.

Plastics Eng. Hbk. of the S.P.I., 2nd ed. 1954. New York: Reinhold Publishing Corp.

Powers, W. J., in C. E. Schildknecht's "Polymer Processes." 1956. New York: Interscience Publishers, Inc.

Company literature: Bakelite, Celanese, Dow, Du Pont, Eastman, Monsanto, Rohm and Haas, and other materials suppliers have available literature on various phases of adhesive bonding of plastics. Consult literature for additional information.

MACHINING THERMOPLASTICS

BY GEORGE CARLYON*

Virtually all the thermoplastics can be satisfactorily machined, using the same type of setup as is used for such soft metals as yellow brass, provided allowance is made for plastics' greater sensitivity to heat.

Thermoplastics are also poorer conductors of heat than are metals, and so suffer from a greater buildup of heat during the machining process. At the same time, they have a much greater thermal expansion rate. Finally, being thermoplastic, they soften or distort at temperatures well below those which may be generated by machining.

When these factors are ignored in the machining of thermoplastics, gumming or tearing of the plastic, or binding and sticking of the tool may result. Excessive strains may also be introduced in the piece which is being machined.

General recommendations

Generally, these results can be prevented by: 1) the use of coolants wherever possible; 2) the use of a tool design which gives adequate clearance; and 3) the operation of tools at relatively high speeds and at a slow rate of feed.

The following recommendations apply, *in general*, to all thermoplastics and all machining operations.

Coolants: A water-soluble cutting oil or compressed air jet—which also clear chips out of the cut—make the best coolants for cutting tools. Other liquid coolants may contain chemicals which could attack thermoplastics. A 10% solution of oil and water is probably best for most applications.

Tool design: In most cases, tools should be set with a zero or slight negative rake, and should have a scraping rather than a cutting action. This tool design facilitates the clearance of chips. At the same time, it minimizes a tendency of the more resilient plastics, such as the fluorocarbons, to flex away from the tool during turning operations. Tools should be kept sharp, clean, and free of nicks and burrs to prevent chipping and to minimize frictional heat.

Because of their high rate of heat buildup, plastics are often harder on tools than metals several times as hard. Wherever production runs will justify, carbide-tipped tools are recommended. They have a much longer life between sharpenings, produce a cleaner cut, and can be operated at higher speeds. For most ordinary machining operations, high-speed steel tools specially designed for use with plastics are also available.

Tool operation: Tools should be run at as high a rate of speed as practical. Experience will determine the proper rate. Before starting production runs on any unfamiliar plastic, a few sample parts should be made. A smooth, continuous flow of ribbon-type shavings is evidence of good procedure. The tool is operating too fast or otherwise overheating if it produces scorched, stringy, or web-like chips.

The feed should be uniform and moderate. If the feed is uneven the piece may become marked. Attempts to remove too much material at one cut will result in chipping, chattering, or other damage to the piece. On turning

* Vice Pres.-Mfg., Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Recent Developments and References were prepared by the editors.

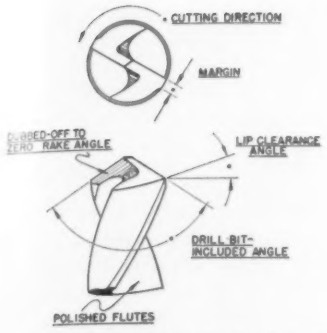


Fig. 1: Schematic drawing of drill used for thermoplastics. (Sketch, Rohm & Haas Co.)

operations, a light finishing cut will produce a smooth, semimatte finish, requiring little or no polishing for most applications.

When close tolerances are required, thermoplastic parts should be inspected at a standard temperature (usually 72° F.). The part should be stress-relieved at critical stages in the machining process. Since the piece may expand considerably during prolonged machining, allowance must be made for the subsequent contraction on cooling. It is wise to make the final sizing cuts after the piece has cooled completely to room temperature.

Specific recommendations

Acrylics and *nylon* machine very well—better than many metals. Properly annealed parts have been made to tolerances of ± 0.0005 inch.

Nylon is highly water-absorbent. When close tolerances are required, it is boiled in water before machining until it has a moisture content equal to that which it will have when it is in service.

Fluorocarbons and *polyethylene* also machine well but require more care to hold close tolerances because of their exceptionally high rate of thermal expansion and their flexibility. For turning operations on these plastics, enough stock must be left for an adequate cut, or the tool may simply slide over the piece, elastically compressing it without cutting it.

In their most common gages—up to ⅛-in. in many cases—*acetate, vinyl, high-impact styrene, fluorocarbons, polyethylene,* and *nylon* may be punched, blanked, or sheared to size.

General-purpose *polystyrene* is highly brittle and must be worked with a coolant and slow feeds. Annealing is definitely desirable.

Sawing

Most of the saws used for cutting metals may be used for plastics. Where the economics of production do not justify carbide-tipped blades, high-speed steel blades designed especially for the cutting of plastics are available. Steel blades should be hollow-ground. Carbide blades, particularly for circular saws, are recommended with "square and advance" teeth, designed so that alternate teeth start and finish the cut. A coolant is not needed in most cases with carbide tools.

Circular saws produce best results on long, straight cuts or thick material. To minimize chipping, the saw blade should project above the table just a little higher than the material's thickness.

A *panel saw,* or traveling circular saw, produces best results on stacks of several sheets or single sheets over 2 or 3 ft. long, on sheets with vulnerable surfaces (such as unmasked acrylic), or on trimming of irregular edges. The saw is moved by hand crank or

RECENT DEVELOPMENTS

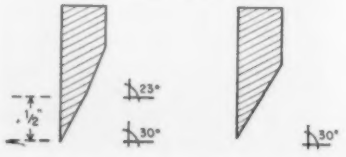
Beside-the-press grinders (*Models 3X* and *3XX*) of the new foremost grinders have extra-large throats and are especially designed for grinding scrap molded parts as well as trimmings from thermoformed sheet. The *3X* has a throat opening of 10 by 16 in. and is powered by a 5-hp. motor, while the *3XX* has a throat opening of 10 by 24 in. and has two 5-hp. motors. *The Rainville Co., 224 Seventh St., Garden City, N. Y.*

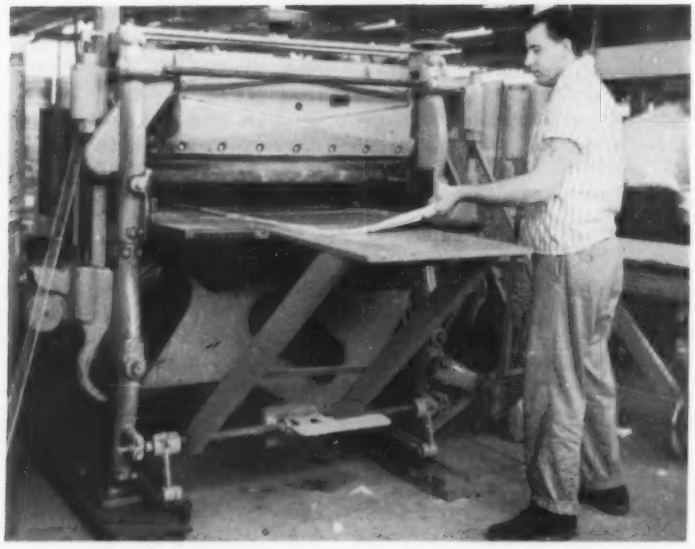
The "Flying Cutter" is a circular saw that has virtually no dip or gullet between its teeth. The carbide teeth are welded into the rim of the saw blade in such a way that they protrude slightly above the circumference. This construction, it is claimed, eliminates grabbing and saw-cut flash. It is satisfactory for thin plastic extrusions that cannot be cleanly cut with conventional saws. Ten to thirty times as many cuts can be made between sharpenings as with conventional blades. *Lemmon and Snoap, Grand Rapids 4, Mich.*

A roller-type die cutter will cut parts from continuous roll stock up to 72 in. in width. The roll stock is fed between power-driven pinch rolls that pull a predetermined length of stock from the supply roll. The loose stock trips a switch that moves the cutter roll to the rear of the machine while two other pinch rolls pull the stock onto the cutter bed over the dies. The cutting roll then traverses the bed, making the cuts. *Falls Engineering & Machine Co., 1734 Front St., Cuyahoga Falls, Ohio.*

A new drill for sheet plastics (*Roto-Bor*) is a different approach to the problem of cutting holes in a thin sheet, something difficult to do with standard drills. It consists of two rotating points centered on a shaft having a pointed retracting positioning tip. Mounted in any drill press or hand drill, it cuts through the sheet around the circumference of the circle only, in somewhat the fashion of a hole saw. Result is a clean cut and an accurate, chip-free hole. *Jancy Engineering Co., 508 S. Pine St., Davenport, Iowa.*

Fig. 2: Recommended cutting edges to be used on resilient, rigid thermoplastics materials. (Drawing, Bakelite)





Heavy flexible vinyl sheet can be sheared to size with sharp-edged steel rule dies at room temperature. Rigid vinyl should be heated before shearing

power along guide rails above the work, while the sheets remain stationary, usually under a hold-down bar.

Band saws are used to cut curves in flat sheets or for rough trims of formed parts. Though not as accurate as circular saws for straight cuts, they can be used on short cuts and run cooler than circular saws.

Special band saws, known as skip-tooth or buttress saws, have been developed especially for plastics and soft metals. They have coarse teeth and extra-wide gullets to give clearance to the large plastic chips.

For most plastics the higher the speed in ft./min. of blade travel the better the resulting cut will be.

Jig saws may be used to cut closed holes or small radii in thin stock, whenever other methods are not practical. Blade tooth clearance should be sufficient.

Routers

Routers are used to shape curved sections or to cut formed parts to size. Smooth cuts can be obtained by using straight, two-flute cutters at high spindle speeds and slow-to-moderate feeds. When portable routers are used for cutting, the sheet or part should be clamped to a table. If many identical pieces are to be cut, a templet can be used both as the bearing surface and guide for router.

Drilling

Twist drills specially designed for thermoplastics are readily available. These provide maximum clearance for the cutting edges. They have a zero or negative rake angle, and extra-wide highly-polished flutes and lands. A drill design with much longer flute leads than are conventionally used will permit the attainment of higher production speeds.

The work should be securely held and a slow, careful feed used when "breaking through" to avoid chipping.

In deep holes, the feed should be slowed, and drills should be backed out frequently, to clear the chips and avoid excessive heat buildup.

Compressed air can be used as a coolant for holes of moderate depth. Water-soluble oil can also be readily squirted into the hole by means of plunger-operated oil cans. A pilot hole may be drilled and filled with a wax stick. The wax acts as a lubricant and supports and expels the chips. In transparent plastics, this method produces smoother and more transparent holes.

In deeper holes, a jet or oil-hole drill will feed soluble oil coolant directly to the proper point.

Large-diameter holes can be cut with *hollow end mills*, *fly cutters*, or *hole saws*, or they can be bored.

Turning, threading, tapping

Standard machines can be used for most thermoplastic turning and threading operations. Tools should have a zero-to-slight negative rake and should be kept as sharp as possible to insure clean cuts. Threads can also be die-cut. Alignment of the work and die must be perfect to obtain best results.

In turning the resilient plastics such as nylon which produce a continuous chip that may wrap around the work, a chip breaker can be ground on the tool to overcome the problem.

Taps for thermoplastics should have a slight negative rake and should produce threads with slightly rounded grooves. This gives better clearance of chips and avoids cracking at the root of the thread. Standard taps and dies for copper and brass may be used, if thus modified.

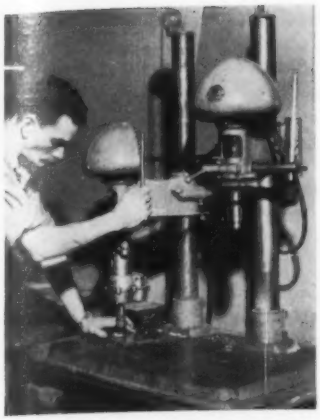
A special tap has been designed for plastics and soft materials. It has two flutes and two cutting edges, instead of the usual four, to facilitate chip removal.

National series coarse threads should be used wherever it is found to be possible.

Taps should be backed out pe-

Threads are easily turned on cast acrylic rod. Tools used should generally have a zero-to-slight negative rake





Taps for use on thin acrylic sheets should be backed out periodically to clear the threads of chips and to avoid stripping

riodically to clear the threads of chips and avoid stripping. Lubricants should always be used. In some cases, a wax stick inserted into the drill hole prior to tapping will serve as an adequate lubricant and also serve to expel chips. In clear plastics, this also produces a cleaner, more transparent thread.

Shearing, blanking, punching

In relatively thin sheets, most thermoplastics can be sheared, blanked, or punched to size with sharp-edged steel rule dies more economically (in quantity) than they can be sawed or drilled. Standard hand or power presses or slitters can also be used.

Small nonprecision parts can be punched out in a single operation. High speeds are possible with well-made dies. Steel rule dies may be operated in presses similar to those used in the printing industry, the rubber or leather industry, or in standard metal punch presses.

For large production quantities, closer tolerances, and/or the heavier-gage materials, all-steel dies operated in standard metal punch presses would be the proper

Blanking, even in heavy thicknesses, is highly economical when intricately shaped parts are to be formed and dimensional tolerances are not too close.

Shearing or blanking of thin sheets in stocks is not recommended with most plastic materials because the sheets tend to adhere at the edges.

Specific recommendations for cutting plastics sheets are as follows:

Acetate, butyrate, flexible vinyl, and polyethylene, in thicknesses up to ⅛-in., may be cut at normal room temperatures by many means, including simple hand snips. Acetate patterns may be scored with a sharp knife and then snapped out of the sheet. This is often used to make intricate templets.

Rigid vinyl, above 0.015 in. in thickness, should be heated to about 160° F. before blanking or shearing.

High-impact styrene can be cut cold with blanking dies in many cases. Where intricate shapes are to be cut, it is advisable to heat to 160° F.

Nonprecision parts of *nylon* up to ⅛ in. and *fluorocarbon* or *polyethylene* parts up to ¼ in. can be punched or blanked cold from sheet or strip in many cases. If cracking occurs in nylon or fluorocarbons, it can be overcome by preheating the strip or soaking it in water.

Punching and shearing of regular *polystyrenes* has not been found practical in most cases. However, oriented polystyrene sheeting can be punched and sheared readily.

Grinding

Thermoplastic rods can be production sized by centerless grinding to tolerances as close as ±0.0005 inch. A silicon carbide wheel with an open grain is used in a water jet. Abrasive wheels are not normally used for cutting, as they tend to burn the stock.

Finishing

After fabrication, most articles require some form of finishing to remove tool marks and restore natural luster to the material. Care in the final machining cut will minimize the amount of finishing required.

The friction of buffing, sanding, or polishing too long or too vigorously in any one spot can generate enough heat to burn or soften a thermoplastic surface. The part should be kept constantly in motion relative to the wheel to keep heat buildup to a minimum. The direction of buffing should be changed often. Machine sanders for finish work should be run with coolant.

Filing: A "Vixen" file, such as is used on aluminum and other soft metals, with deep, single-cut coarse teeth, is effective in working thermoplastics. Files designed specifically for plastics materials are also available.

Sanding: Where sanding is indicated, a coarse wet or dry sandpaper is used, followed by successively finer grits until a satin finish is obtained. Wet sanding is usually most desirable.

Ashing and buffing: Ashing is a semifinishing operation on a cotton or muslin wheel with a slurry or paste of fine pumice and water. It will remove most light scratches and saw marks without prior sanding. The part should be washed after ashing or buffing to remove excess compound.

Finish wheels: Following ashing, buffing with Tripoli or a chrome-coloring compound, followed by a soft loose wheel on which no abrasive is used, will give a high luster. For the final operation, a coat of wax, preferably antistatic, is sometimes applied. This is preferred for many applications because of its water-resistance and nonattraction to dirt or dust particles.

Solvent polishing: Acetates, bu-

Large holes are blanked into high-impact styrene sheet with steel dies. The 10-gage sheet can be worked cold without any damage to the sheet



tyrates, and the acrylics are sometimes polished by immersing the parts for a few seconds in acetone, butyl acetate, ethylene di-chloride or other proper solvents, or by exposing them to the solvent vapor in a vapor chamber. The solvent reacts with the surface of the plastic and forms a film which dries to a high gloss.

Acetate or *butyrate* articles may also be wiped with a cloth which has been dipped into a solution of 95% isopropyl alcohol and 5% methyl Cellosolve acetate. The cloth should be saturated afresh before wiping each piece.

Because of the volatility of most solvents, adequate ventilation must be provided to eliminate inhalation of the harmful vapors, and precautions taken to avoid fire or explosion.

Acrylic parts which have been solvent-polished or flame-polished should be thoroughly annealed at maximum temperature to prevent crazing.

Flame polishing can be used for the polishing of acrylics, particularly for slots and inaccessible areas. An oxy-hydrogen flame is used, with nozzle held about 4 to 6 in. from the stock and moved along slowly (about 4 in./sec.). Too slow a speed will overheat and may result in slight bubbling of the surface; a second application of the flame—after the material has cooled—will usually restore the surface.

Acetylene flames should not be used as they tend to deposit carbon on the surface being polished and on adjacent areas.

References

For information on properties of thermoplastic materials, see the Plastics Properties Chart. Also consult the Subject Index and the Directory Index.

"Drilling coolants," MODERN PLASTICS *31*, 190 (Oct. 1953).

"Factors affecting the high-speed tapping of plastics," W. M. Halliday, Plastics (London) *18*, 64 (Feb. 1953).

DECORATING MOLDED PLASTICS

BY LLOYD E. PARKS*

While painting is the last in a long series of steps in producing decorated plastics parts, quality and ease of decoration are dependent on all previous operations. Agreement through compromise must be reached between the artist and the engineer, both making such changes as are necessary to produce quality parts practically and economically.

Design and molding

Plastics parts must be molded relatively free of stresses to avoid unnecessary crazing or cracking in use. Stresses may be introduced when parts are machined, flexed, shocked by impact, or subjected to abrupt and uneven changes in temperature or the action of certain solvents. Crazing results in distinct surface cracks or minute frostlike internal cracks when stresses exceed the tensile strength of the plastics. If when local stresses are present but are less than the tensile strength of the plastic, the part is under strain and may appear perfectly sound but may crack or craze at a later time if additional stresses, sufficient to exceed the tensile strength, are introduced. Quality parts must be molded relatively strain-free and this is particularly important if they are to be decorated by painting (1).[1]

If parts are to be decorated on the second surface, assembly lugs, reinforcing ribs, metal inserts, knockout pins, and sprues must be located with care since they may show through the clear plastic and spoil the effect. If parts are to be spray painted in more than one color, edges and corners must be sufficiently sharp to insure close fitting of spray masks. Narrow deep grooves and small holes must be sprayed at a very small angle which tends to fill the bottom of the groove or hole without coating the side. Paint tends to pull away from small raised angles, making them more difficult to spray than large angles or areas which have rounded surfaces.

If a part is to be silk screened, the area must be flat or at least smoothly curved. If letters are to be filled by the spray and wipe method, they must be sufficiently deep to avoid wiping the wet paint from the indentation.

If parts are to be decorated completely or in part by hot stamping, the method of hot stamping should be determined in advance and the part designed for the operation.

Annealing

Even with the best of design and molding techniques, many parts must be annealed to avoid rejects on the paint line. Some molders anneal all plastic parts; others anneal only those that cannot be molded sufficiently free of strain for decorating. In the case of the latter, the decision to anneal comes after all attempts to adjust paint solvents and molding cycles fail to produce parts satisfactory for decorating.

The most satisfactory method of annealing is to apply heat at a relatively low temperature for a long period of time. Polystyrene is commonly annealed at approximately 140° F. for 4 to 8 hr., depending on the type and size of the part. Acrylic parts may be annealed at 135 to 160° F. for varying lengths of time depending on the type of part and the type of acrylic plastic. Parts of either acrylic or polystyrene may be taken directly from the press and dipped into hot water for annealing. Seven to 10 min. at 140 to 180° F. should be sufficient for most parts. However, the precise temperature and time cycle must be worked out separately for each part.

There is a chance of warping parts in the annealing operation and in some cases it is necessary to clamp them in a jig to maintain shape.

When annealing in a water bath, it is common practice to use a small amount of detergent to promote wetting of the part and rapid draining as parts are removed from the bath. Such wetting agents may also serve to reduce static electricity on the part

* President, Parks & Co., 205 S. Church St., Charlotte, N.C., and Associate, Logo, Inc., 12933 S. Stony Island Ave., Chicago 33, Ill.
Recent Developments were prepared by the editors.
[1] Numbers in parentheses link to numbered References at the end of this chapter, p. 834.

Designs **of genuine sterling silver, gold, or gleaming nickel** can now be applied directly to black or colored plastics materials. The metal is applied electrolytically and is guaranteed not to chip or rub off under normal use and care. *G.M.C. Process Corp., New York, N. Y.*

Rubber-faced design rollers for flexographic printing of continuous over-all designs are now available as lightweight, slip-on "D-Mount" sleeves. Made of a light-metal alloy, the sleeves are designed to fit interchangeably on a special shaft built to insure very close tolerances. Disassembly is simple, permitting rolls to be stored while the shaft is in use with another roll. The rubber printing surface is molded to the customer's design and vulcanized to the metal backing. Available for single- and multi-color designs in face sizes up to 90 in. and diameters up to 9 inches. *Mosstype Roller Co., Inc., Waldwick, N. J.*

The Kensol 60 roll-leaf stamping press applies permanent, fine-quality trademarks, decorations, directions, etc., on almost any kind of plastics, including thermosets. It will mark both flat and high (up to 5.5 in.) items and has a wide range of pressures obtained by using two air cylinders in the imprinter drive. (One can be inactivated when making light imprints.) Dwell is electrically timed. Head and roll-leaf attachments come in two sizes: 6 by 8 and 8 by 12 in., with larger sizes available on special order. A 6- or 12-station turntable attachment is one of several feeders available. *Olsenmark Corp., 124-132 White Street, New York 13, N. Y.*

A flocking machine weighing only 80 lb. features, aside from its compactness, a tilting supply hopper that makes it easy to empty unused flock or to change quickly from one color to another. The machine has only two moving parts: a sparkproof blower and a long-stroke magnetic-vibrator feed mechanism that is built into the feed hopper. The feeder is wired so that it cannot operate unless the blower is running, thus preventing overloading and clogging of the blower. Once-a-year cleaning is sufficient for both the totally enclosed motor and the feeder. The unit is used in conjunction with an adhesive spray gun: the operator can spray adhesive with one hand and apply flock with the other. *Progressive Equipment Co. (PECO), 8625 Mackinaw, Grand River, Detroit 4, Mich.*

In this combined spray booth, spray painter, and mask washer, parts to be sprayed are fitted into workholders—which may also act as masks—and mounted on the machine spindle. As many as four guns spray paint on the spinning part. Speed of rotation ranges from 40 to 400 r.p.m. and the pedal-activated guns stop automatically at the end of a timed period. One mask is automatically washed in an agitated solvent bath while the alternate is being sprayed. This procedure is safer for the operator and less likely to damage fine wire bridging on masks. *Conforming Matrix Corp., 364 Toledo Factories Bldg., Toledo 2, Ohio.*

---

and thus reduce the amount of dust collected between annealing and decorating. Such wetting agents should be selected with extreme care, since they remain on the part and may adversely affect paint adhesion.

Cleaning the part

It is desirable that plastics parts be designed so they can be molded relatively strain-free without the use of mold lubricant. Mold release lubricants interfere with paint adhesion and must be removed (Fig. 1, p. 830). Moderate amounts of stearate lubricant may be removed with solvents which do not attack the plastic surface. Silicones are more difficult to remove with solvents. The Dow Chemical Co. (2) recommends a solution of 4 oz. of Oakite No. 24 in 1 gal. of water for removing silicone lubricant. A 20-min. immersion of the molded part in the solution at 145° F. is recommended, followed by a water rinse. This solution will also remove stearates and other contaminants.

Parts should also be dust-free for decorating. It is helpful to dip the parts in an antistatic solution immediately after molding to reduce the amount of dust contamination between molding and painting. Antistatic agents which do not adversely affect the paint adhesion must be chosen.

Some parts are wiped just before painting to remove dust and other contamination.

Paints used

Plastics differ in physical and chemical properties, and these differences affect the type of paint required. It is, therefore, important to select a paint specifically for the plastic to be decorated.

In the plastics industry the term "paint" is used broadly to cover both lacquers and enamels (3). Lacquers are particularly desirable for use on thermoplastic surfaces since the film hardens without baking. This eliminates the possibility of heat shrinkage and warpage of molded parts. Also, parts rejected because of blotches or errors in painting can usually be reclaimed quite easily by removing the paint with a combination of paint solvents inactive toward the plastic. Enamels harden by solvent evaporation and subsequent oxidation or polymerization or both. Enamels may be considered as thermosetting and are particularly useful for thermosetting plastics such as phenolic, polyester, urea, and melamine where reasonably high baking temperatures can be tolerated without damage to the plastic part.

Colors: Plastics parts are deco-



Fig. 1: Mold release lubricants interfered with paint adhesion in the piece on the left. The numerals are depressed into the second surface, painted in a light color, and viewed through the plastic. The white areas indicate where the paint "bridged," or pulled away from the corners in the bottom of the numerals. It is necessary that lubricants be removed before painting

rated to make them look better; in most cases the paint serves no other purpose. Accordingly, color is most important. To facilitate production color matching and color control, it is recommended that designers use a reasonable number of pigments, no more than three or four at the most, in arriving at colors. It is most important to work with single pigment colors in blending at the design stage. It is a mistake to blend three or four matched colors, each of which may contain three or four pigments and expect an exact or even an approximate match in production.

Preparation for use: Paints are mixtures and in all cases it is necessary to stir well before using to assure uniformity. Unless careful study is given to selecting an alternate, the recommended thinner should always be used. Adhesion, gloss, humidity blush resistance, cratering orange peel, etching (Fig. 2, p. 831), crazing, dry time, and stability of the paint system may depend on the thinner.

Control: In setting up a decorating job it is important that paints be evaluated thoroughly and specified to meet the requirements of the appplication. Such points as grease resistance, humidity resistance, stain resistance, light resistance, heat resistance (Fig. 3, p. 832), abrasion resistance, gloss, adhesion, viscosity, and percent solids should be checked. Once the decorating job is under way, it is impractical to check all these points on each incoming batch of paint. Such control is unnecessary since it is improbable that basic errors in formulation will occur that cannot be detected by less extensive routine control.

However, each batch should be thoroughly mixed and checked for color. If special thinners or retarders are used to correct problems in production, the color should be watched to catch any irregularities that might arise from improper compounding.

Production parts should be checked by visual inspection and a spot check should be made for adhesion. Many companies have accepted transparent Scotch tape #600 and masking tape #202 (Minnesota Mining and Manufacturing Co.) as the standard materials for the adhesion test.

Methods and equipment

In decorating molded parts, color is added by spraying, silk screening, dipping, rolling, or hot stamping. Basically these are the same methods used for years in decorating other surfaces (4, 5).

Spray coating: Spray coating is widely used for decorating all types and sizes of plastics parts. The method is particularly adaptable for painting large areas and uneven surfaces and for the application of multiple colors by the use of spray masks. Spray coating is quite economical as a decorating method and productivity is high in well-equipped paint shops.

Suction feed guns and reasonably small suction cups are commonly used in spraying small areas and parts in short runs. Uniformity of the paint film depends on careful adjustment of paint viscosity, air pressure, and upon the gun opening.

Pressure feed tanks are used almost exclusively for spraying large areas or in long runs requiring a large volume of paint. The tank is connected directly to a conventional hand or automatic spray gun by a fluid hose and the paint is forced from the tank to the gun by air pressure. Since pressure feed tanks are stationary in operation they should be equipped with air agitators to keep the paint well mixed. This is particularly important in the spraying of paints in which particles such as pearl essence and metallic powders have been suspended.

Uniformity of spray application is particularly important in spraying metallic and pigmented metallic finishes. If one panel is sprayed extremely dry and another extremely wet, the colors may differ appreciably due to the difference in the degree of flooding of the powder. If sprayed dry, the film may be almost immobile when it hits the plastic, thus allowing very little flooding or orienting of the powder. If the film is extremely wet, the powder may flood excessively, giving a quite different color. (Fig. 4, p. 833.)

For spray application, paint is usually thinned to a standard viscosity suitable for the particular job. It must be thinned sufficiently to spray, yet the resulting film must be viscous enough to hang on corners and edges when the paint hits the part. This is accomplished by use of a low boiling solvent which evaporates between the spray nozzle and the plastic surface, allowing for an increase in viscosity in the paint before it hits the surface. Extra high boiling, high boiling, and much of the intermediate boiling

solvents strike the plastic part with the paint as it is sprayed and control the properties of the wet paint film. Groups of solvents are classified in Table 1, below.

Spray masks

Parts may be decorated with several colors by a series of successive spray operations using a series of electroformed metal masks that shield certain areas while other areas are painted. Basically there are three types of masks. The *lip mask* may be used for spraying depressed designs, in which case it is form-fitted to the area around the depression with lips extending down the side walls of the depression. A variation of the lip mask is used for shielding raised or embossed designs while the surrounding area is painted. Here again a lip extends down the side walls. Usually it is desirable to have two colors meet on these vertical walls rather than at the surface edge of the area being masked. The *plug mask* fits snugly in a depressed area to protect it while the surrounding area is being sprayed. It does not have a lip. The *block mask* confines paint to the general area of a small design or group of designs and is commonly used in filling operations where excess paint must be removed by wiping.

Electroformed lip and plug masks must fit accurately for good work and this usually means a different set of masks for each mold cavity. Accordingly, it is highly desirable to have masks fitted to good production parts. Masks should be handled with reasonable care in operation and should be held snugly to the parts while the paint is being applied. A poor fit will allow paint to blow by with a resultant clean-up cost on a sloppily decorated part.

Precision masks may be held in place by hand and gravity. However, there are many air clamping devices available for holding them in contact with plastics parts for decoration.

The book-type lip mask in Fig. 5, p. 833, is used for painting the wide dark stripe around the center and the narrow dark stripe around the top of the model bus body. The part is located on a nesting block and again the mask is closed by a pedal-operated air clamping type arrangement.

Masks of several different types may be required to decorate one part.

Paint accumulates on masks as successive parts are sprayed and must be removed at regular intervals for good production. The number of parts that can be sprayed before the mask is washed will depend on the job and to a certain extent on paint formulation. However, under the best conditions, masks must be cleaned quite often. This may be done with a solvent such as acetone and a hand-brush operation or with one of various types of automatic mask washers.

Screen process printing

The general subject of screen process printing has been covered in detail by Kosloff (6) and most of the general technology is useful in decorating plastics.

The process is used extensively for printing both flat and curved surfaces on a wide variety of molded parts. It is particularly adaptable for multi-color decorating by successive screening operations with a series of different screens. It is more economical than spraying for decorating elaborate designs.

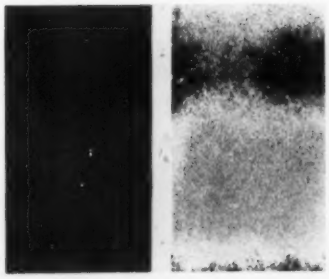


Fig. 2: Since metalizing accentuates defects, proper lacquer base coat must be applied before metalizing to get good finish (left) (brightness shows as black); improperly thinned coat causes defects (right)

The basic equipment used in screen process printing is the screen, commonly called the "silk screen," regardless of the fabric used in its construction, and the squeegee which is used to force paint through the design in the screen to the part being printed.

The screen consists of a taut woven fabric securely attached to a rectangular wooden framework and carefully masked with a stencil in a manner that will allow paint to be pressed through the fabric only at areas where the stencil is open.

Woven silk, nylon, copper, stainless steel, and many other materials are used in making blank screens. Nylon has replaced silk and is perhaps the material most commonly used in screens for printing molded plastics parts.

The mesh of fabrics used in screens for such work usually varies from 125 to 150. However, screens are commonly classified by the number classification of the fabric used. By this system, numbers 12, 14, and 16 screens are most common. As the number increases, the mesh of the screen becomes finer, with a resultant thinner film of paint on the printed part. Thin films give better detail but may result in poor hiding.

Design printing: For design printing, a stencil must be added

TABLE I: Classification of paint solvents

Low boilers	*Intermediate boilers*	*High boilers*	*Extra high boilers*
Methanol	Isopropyl alcohol	Amyl acetate	Cellosolve acetate
Ethyl acetate	Sec-butyl acetate	Butyl acetate	Butyl Cellosolve
Isopropyl acetate	Methyl Cellosolve	Butanol	Butyl lactate
Acetone	Methyl isobutyl ketone	Diisobutyl ketone	Methyl carbitol
Methyl ethyl ketone	Toluene	Xylene	SC-150
Hexane	VM & P naphtha	SC-100	
Heptane		Methyl Cellosolve acetate	

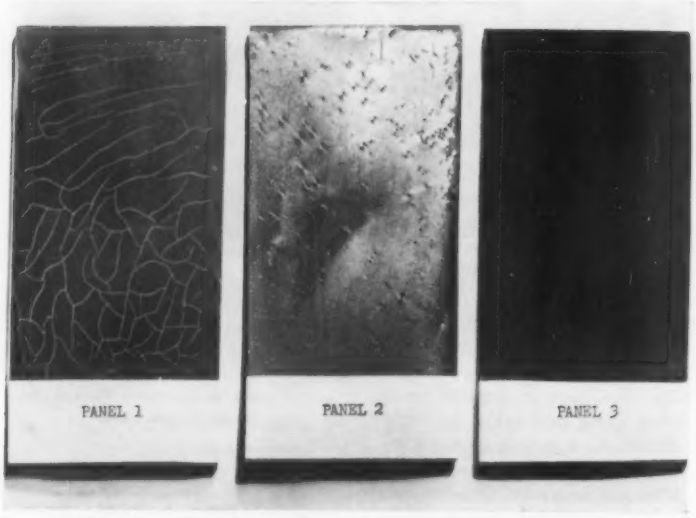


Fig. 3: Important consideration in selecting lacquers is heat resistance. In metalized panels above (brightness shows as black), three different lacquer systems were used. Panel 1 failed after 15 min. at 170° F.; panel 2 failed after 30 min. at 210° F.; panel 3, under the same conditions, did not fail

to the blank screen. This may be accomplished by several methods. However, simple water-adhering film and photographic stencils are generally used in screens for printing molded parts. Sheet stock designed for water-adhering film stencils is available from The Craftint Mfg. Co., Cleveland, Ohio, and other suppliers. It consists of a water-soluble film backed with a thin sheet of plastic or specially prepared paper.

Photographic screens are used extensively and are particularly desirable for intricate designs. Essentially the process is quite similar to printing a snapshot from a negative. The commonly used positive film is called "carbon tissue" and consists of pigmented gelatin emulsion, or a similar colloidal film supported by a backing which can be a flexible plastic.

Applying the paint: The squeegee is a tool used to force paint through the design area of a screen in the painting operation. It is made of solvent-resistant material and is equipped with a handle for hand operation or with a holding device which can be designed to be used in machine operation.

The squeegees are usually about 0.25 to 0.50 in. thick and for good printing the working corners must be kept sharp by sanding the bottom or working end. A small vertical jig with a slot about as wide as the thickness of the squeegee and with fine sandpaper in the bottom is useful for this operation. Squeegees must be kept clean and it is desirable to have a different one for each color. For a particular operation, the squeegee should be slightly shorter than the inside of the screen frame to allow ease of operation, but it should always be long enough to cover the entire design area in just a single stroke.

The flat plastic part is placed under the screen, in register, and the screen adjusted for a clearance of approximately ⅛ inch. This clearance serves the purpose of allowing a line contact as the squeegee is pulled across the screen under pressure in the printing operation. The operator takes the squeegee firmly, preferably in both hands, and dips it into the paint, leaving a small amount in front of the squeegee along its entire length. It is then pulled forward over the design with an even stroke and enough pressure to make a line contact with the plastic part as it moves. The squeegee is returned to the back, the screen lifted, and the printed part is then removed. Good screening paints or inks are available for use on practically every type of plastic including treated polyethylene. Paint must be selected, however, for the particular job and for the plastic to be decorated. Generally speaking, lacquers are more desirable than enamels for printing thermoplastics, as was the case with spray finishing. Enamels are generally more desirable than lacquers for thermosets.

Some molded plastics parts are screened by automatic or semi-automatic setups when volume production is required. This is particularly true of parts such as bottles and containers which often have curved surfaces.

Dip coating

Dip coating is economical and is used widely in decorating novelties, toys, and other objects that require only one color and are so designed that excess paint will drain off without being trapped. From the standpoint of appearance, dipping gives a very uniform paint film but it should be noted that rapid production prohibits application of uniform paint thickness. If parts are withdrawn from the dip tank at a rate faster than they drain, the film will be thicker at the bottom and excess paint will remain on the bottom edge as a line or tear. Such tears may be removed by spinning the part or by hand wiping at some extra cost. For large scale production it may be desirable to remove parts slowly for better drainage.

When pigmented paints are used, some method of agitation must be arranged to assure uniformity of the mixture. This may be accomplished by pumping material from the bottom to a point just beneath the top surface of the paint mixture or it may be done with a mechanical agitator as long as the formation of air bubbles is avoided.

The solvent system of dip finishing must be adjusted to allow good flow-out and drain without sagging. The gel time and film thickness may be controlled somewhat by use of low-boiling solvents which serve to reduce the viscosity of the paint in the

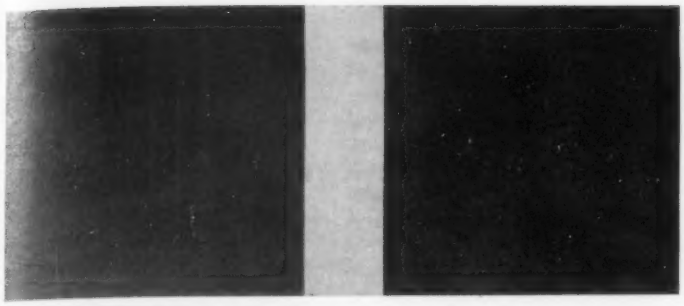


Fig. 4: Although paint was kept well mixed, panel at left, sprayed "dry," is lighter and less grainy than panel at right, sprayed very wet. Flooding is most likely to occur with paints of low viscosity. (Photos, Logo, Inc.)

dip tank but evaporate rather rapidly on application. Paint in dip tanks may lose solvent with a resultant increase in viscosity. This can be corrected by the addition of the proper make-up thinner.

Parts may be dipped singly, by hand, or by jigs that hold several parts. If they are withdrawn more rapidly than they drain, a drain board must be provided to catch drippings. Chain conveyor installations are used for large-scale production.

Roller coating

Small raised areas such as letters, figures, and designs may be decorated with paint by roller coating. This method is particularly useful in many cases as an alternate for hot-stamping. It has an advantage over spray coating for such operations in that simple loose-fitting block masks may be used or the part may be rolled without a mask. For best results the raised areas should have smooth flat surfaces and all points to be roller coated in one operation should be in one plane or at least be in a cylindrical arc. The edges and corners should be sharp for good detail.

The paint must have good adhesion since many raised areas are especially subject to wear. The solvent system must be balanced to allow flow out but the film must gel or become immobile before it has a chance to run off the raised area.

Hand rolls are commonly used for short runs and for areas that cannot be rolled by machine. A small amount of paint is placed on a flat surface such as glass and the roll is coated by rolling it back and forth in the paint. The coated roller is then moved back and forth over the raised area to transfer the paint. Automatic roller coating machines are available for handling large runs but must be adapted to the particular job.

Fill-in marking

Depressed letters, figures, and designs on either the first or second surface of plastic may be easily and rapidly filled by the spray-and-wipe method. A single depression or a series of depressions with a loose-fitting block ing the general area without a mask, or spray coating a restricted area around the depressions with a loose-fitting block mask. The job is completed by buffing or wiping the excess paint from the area surrounding the depressions. The wiping operation may be performed by hand or it can be accomplished with an automatic machine.

In the automatic setup, parts are secured in a cup-like jig and raised by an air lift for wiping. The shaft holding the parts rotates, thus wiping the part on the cloth as pressure is exerted by the opposing cushioned jig.

Enamels must be removed before they cure and it is desirable that lacquers be wiped before they are completely dry. Since regular lacquers and enamels are sticky by nature, it is always necessary to remove the last traces with a solvent which does not attack the plastic. Spray-and-wipe finishes must be formulated to avoid etching the plastic. In the case of second surface decorating, etch will show up against the color subsequently applied over the area; it will also mar appearance in the case of first surface decorating, particularly if the area surrounding the fill-in is not painted.

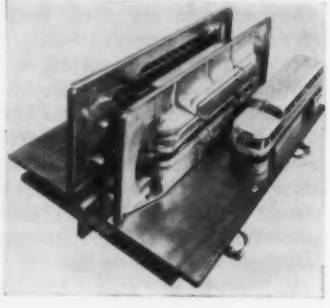
"Dry-wipe" formulations are generally more desirable than regular lacquers and enamels for spray-and-wipe fill-in. These highly pigmented materials are easy to use and may be wiped or buffed without a solvent over a period of time ranging from about 20 min. to several hours after spraying. Generally these materials have poor gloss as a result of the very high pigmentation and it takes them several days to reach maximum hardness. They can be packed or further decorated almost immediately after the buffing operation; if parts are to be decorated by the spray-and-wipe method, the depressions must be rather deep and narrow to avoid complete removal of the paint in the wiping or buffing operation.

Roll-leaf hot-stamping

Molded plastics parts may be decorated rapidly and economically by roll-leaf hot-stamping. The process is particularly good for relatively small letters, figures, and designs, and may be used for reasonably large areas if care is taken that the parts are properly designed.

Roll-leaf consists of a flexible ribbon of paper, cellophane, cellulose acetate, or similar sheet stock with a colored coating on one side. The hot-stamping proc-

Fig. 5: Book-type lip mask for painting wide dark stripe around center and narrow dark stripe around top of toy. (Photo, Conforming Matrix)



ess consists of transferring this coating from the flexible backing to the molded plastic part by pressure and heat.

Roll-leaf is supplied in a wide range of both transparent and opaque colors, and is available with several different types of coatings formulated for adhesion to various kinds of plastics. Hot-stamping equipment varies from the manually operated press to the completely automatic setup.

The plastics part is nested firmly in or on a jig under the head of the press, and the roll-leaf, fed under the head of the press, is brought into pressure contact with the plastic by an electrically heated die in the press head. Contact is held for a dwell time sufficient to soften the coating and transfer it to the plastic surface where it is bonded by the heat and pressure. Contact is then broken and the stamped part removed for further processing or packing. No drying of the part is needed.

Hot-stamping introduces rather severe stresses into plastics parts and it may be desirable to anneal such parts before decorating them further with paint or before putting them into use.

Clean-up and inspection

Clean-up and inspection are important last steps in the decorating process. The amount and type of cleaning required depends on the type of part decorated and the type of decoration used. For example, clear parts that have been spray-decorated on the second surface may have a collection of paint over-spray on the first surface that can be removed by wiping the entire area with a solvent that does not attack the plastic. For most plastic surfaces this is a simple operation when lacquers are used. However, when enamels are used, over-spray must be removed before it sets or cures. Such a wiping operation will remove other surface contaminants including dust. Antistatic preparations may serve as a cleaning solvent and at the same time reduce the static charge on the plastic part, thus protecting it from dust collection in shipment and future use.

The amount and type of inspection depends on the particular job and a statistical study of the operation. A sufficient number of parts should be inspected to assure shipment of parts that will meet the customer's specifications. Inspection of decoration should include a visual check for craze lines, etched surfaces, color of decoration, gloss of finish, coverage, and general appearance of the over-all job.

References

1. Parks, Lloyd E., "Painting and metallizing of plastics," SPE Journal *12*, 17 (Feb. 1956) and *12*, 35 (Mar. 1956).

2. The Dow Chemical Co., "Coatings and finishes for Styron," Plastics Technical Service, 7 (Feb. 1953).

3. Parks, Lloyd E., "Color paint, and plastics," MODERN PLASTICS *32*, 99 (May 1955).

4. Von Fischer, William, Paint and Varnish Technology, 434, Reinhold Publishing Corp. (1948).

5. Payne, Henry Fleming, Organic Coating Technology, Vol. I, p. 631, John Wiley and Sons, Inc., (1954).

6. Kosloff, Albert, Screen Process Printing, The Signs of the Times Publishing Co., Cincinnati, Ohio (1950).

METALIZING

BY PAUL W. PATTON*

Metalizing or vacuum metalizing is the process employed to deposit metal film on plastic, wood, metal, and other base materials by vacuum thermal evaporation. The term metalizing also applies to such other processes for depositing metal film as metal spraying, chemical reduction, and electroplating.

Characteristics and uses

Vacuum metalizing offers many advantages as a finishing technique for plastics.

1) The process involves little or no heating of the base material, permitting metalizing of heat-sensitive thermoplastics materials.

2) It is an economical method for increasing a product's merchandising appeal to the consumer.

3) Metalized films surpass in brilliance all but the most carefully buffed, polished, and electroplated metals. Reflectivity of aluminum-metalized films usually exceeds 90 percent.

4) Since metallic film is opaque and hence independent of the color of the base material, mixed-color remnants of raw material can be used.

5) Metalizing is adaptable to practically all plastic materials.

6) Molded and fabricated objects can be handled in batch machines. Flexible sheet in roll form is processed in semicontinuous units.

7) Most metals can be deposited by metalizing, although aluminum is used in practically all industrial applications because of its brilliance, low cost, and ease of evaporation. Gold and silver are also used, but in more limited amounts. Platinum, tungsten, nickel, chromium, tantalum, and molybdenum can also be applied.

8) The process is versatile, making it well suited for both job shop operation and long runs.

Decorative and functional

For decorative use, metalizing is to the plastics industry what plating is to the metal-working industry. Plastic novelties, toys, and jewelry items were the first products to take advantage of the low-cost decorative metallic film. Reflectors, advertising displays, and special packaging effects are further examples. Decorative medallions are universally used in automobiles and appliances, and a number of plastic hardware items for general use in plumbing, electrical, and builders' hardware categories are growing in popularity.

Functionally, metalizing offers numerous advantages in places where optical and electrical properties are required. Metalized reflectors for camera flash attachments, bicycle lights, flashlights, automotive lamps, and home lighting devices have opened new markets for plastic products. Metalized printed circuits on plastic base materials, electrical capacitors, and metalized electro-

* Mgr., Vacuum Process Equipment, National Research Corp., 70 Memorial Dr., Cambridge 42, Mass.

Recent Developments and References were prepared by the editors.

static shields on plastics housings for electronic devices are examples of the use of metalizing to produce electrically conductive paths.

Though limited to the production of thin films (the coating seldom goes over five millionths of an inch in thickness), vacuum metalizing is often used on a nonmetallic base to provide an initial electrically conductive coating that can subsequently be built up by electroplating. Phonograph record masters are among the products made by this process.

Designing the part

In designing a part which is to be metalized, blind holes having a depth of more than 1½ to 2 times their diameters should be avoided if the coating is expected to cover the inside of the holes. Sharp edges on wearing surfaces should also be avoided since these areas are subject to concentrated wear which may remove the coating.

The size of the object is, of course, limited by the dimensions of the production coaters—generally, 5- to 6-ft.-dia. cylindrical tanks containing work-holders normally permitting 16-in.-dia. clearance. Generally speaking, the most economical utilization of the coater capacity is made by processing several small parts, rather than a few large parts.

Complicated shapes can be handled with good success, thanks to the excellent "throwing power" of the metalizing process and the opportunity for rotating or revolving parts during the coating process, by means of planetary-motion jigs.

Preparing the surface

Like any quality fiinishing process, materials to be metalized must be clean and free of imperfections when flawless results are required. Lubricants and release agents used in the production of injection molded parts can cause trouble in lack of adhesion and off-color coatings and should be avoided.

Plastics parts having rough or otherwise imperfect surfaces can be made suitable for metalizing by the application of a base coating consisting of an organic finish that will not plasticize the base material. With durable thermosetting plastics which are subject to hard usage, a bake-on finish is appropriate. Less costly thermoplastic materials, which are not subject to rigorous use conditions and which cannot tolerate high-temperature baking can be coated with air-dry or force-dry lacquers. The lacquering operation serves another useful purpose by sealing the surface of the plastic so that it does not give off undesirable volatiles from contained solvents which evaporate when the vacuum is produced.

Depositing the metal

The actual application of the metallic film is one of the quickest, most economical steps in the process. The parts to be coated are loaded in holders. A number of loaded holders are clamped to a jig prior to loading in the coating tank. When all is ready, the tank is opened, the loaded jig is inserted by means of a dolly or conveyor, the door is closed, and the tank exhausted to a pressure of approximately one millionth of an atmosphere (0.5 microns of Hg). Depending on the capacity of the machine and the properties of the load, some 10 to 30 min. may be required to exhaust the tank to the necessary operating pressure.

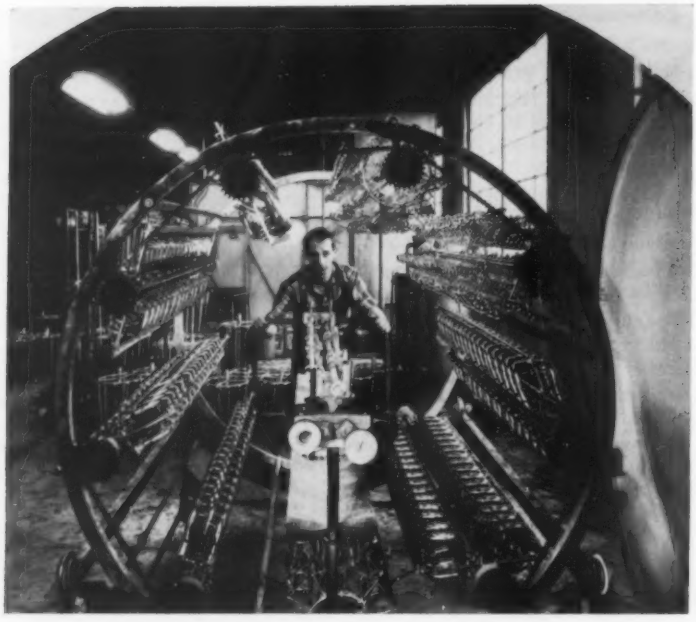
When aluminum is the metal to be deposited, small aluminum staples are hung from coils of stranded tungsten wire filaments. These filaments are connected to the source of the current through several electrodes running lengthwise through the axis of the vacuum chamber. All other metals are evaporated from troughs fabricated of tungsten or molybdenum sheet into a V-shape designed to hold the molten metal.

Metals are heated by direct resistance. A variable power supply brings this "source" up to a sufficiently high temperature to cause the metal to vaporize. The vapor, invisible to the operator as he watches through a sightglass in the side of the chamber, condenses on all exposed surfaces on the inside of the chamber. The heating and evaporation of the metal from the source usually requires less than a minute. Upon completion of this step, the pumping system is valved off, air is let in, the door of the chamber is opened, and the coated work is removed. Individual objects may be left clamped to holders until they are transferred from the jig

RECENT DEVELOPMENTS

In order to produce a faster metalizer the vacuum pumping system of the *Model 427* 72-in. vacuum metalizer has been redesigned. It now has two 16-in. "Ring-Jet" diffusion pumps plus a 6-in. booster pump; these pumps have reduced the time needed to pump down to 0.5 micron to 6 min. or less. The new pumping system is also better able to handle unusual operating conditions, e.g., heavy outgassing from the work or from contaminated chamber walls. The automation features of the older model have been included in the new model. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

A new vinyl-based strippable coating (*Vacuumguard*) can be sprayed or brushed on the inside surfaces of vacuum metalizing equipment to keep the chambers clean. A 2- to 3-mil coating is usually sufficient. When it is properly applied, the coating will be ready for use in less than a day. It is said to be the only such coating that will not outgas under the high vacuums involved in metalizing. When the excess evaporated metal is to be removed, the strong (tensile strength over 2000 p.s.i., elongation about 185%) film is simply stripped out of the metalizer. Precious metals may be recovered from the stripped film simply by dissolving it in aromatic or ketone solvents. *Guard Coatings Corp., 8-05 43rd Ave., Long Island City 1, N. Y.*



Large vacuum metalizing unit provides generous unobstructed interior spaces. A wide variety of sizes and shapes can be handled with work holders and jigs

to a conveyor or materials-handling truck which may be employed in the top-coating process.

Decorative effects

The process thus far described places the metalized finish on the outside surface of the object. This arrangement is known as "first-surface coating" and is most widely used. The exposed surface, being only a few millionths of an inch thick, and consisting of a soft metal, requires protection if it is to withstand abrasion, weather, or other conditions of normal use. Such protection is accomplished by applying a second organic transparent finish over the metalized surface. Color, e.g., gold, copper, bronze, etc., can be obtained by dip-dyeing the lacquer top-coating with an appropriate tint.

An alternative to the first-surface coating decorating technique is the second-surface coating method in which the metalized film is applied to the back of a transparent plastic part permitting the coating to be viewed through the base material. In such an arrangement, the plastic serves to protect the finish. It is used in more expensive decorative medallions, e.g., automotive horn buttons, medallions for appliances, etc. Color in second-surface work is obtained by applying tinted lacquers to the metalized surface.

Equipment and plant

The metalizing unit is the most important and, frequently, the most expensive single piece of equipment in the process installation. On the smaller jobs, the coating chamber is a glass bell; in the more common production installations, a steel tank is used. In either case, the chamber is equipped with a vacuum pumping system that includes mechanical and diffusion vacuum pumps and necessary valves. In the batch coater, in particular, large pumping systems are important to minimize the length of time required until the source can be energized after loading, and the coating deposited. In the usual batch operation, one coater is supplied with two jigs so that one can be loaded and unloaded while the second is in the chamber. Controls for valves, filament power supply pumps, and air bleed are generally centralized in a panel to simplify operation and to permit the provision of sequence control which helps to avoid errors in operation.

Equipment now available will operate with a minimum of downtime provided preventive maintenance schedules are practiced. One cause of downtime is the accumulation of metal on the inside of the tank. This may be removed, in the case of aluminum, by scrubbing with a solution of sodium hydroxide. This practice involves the use of water, residues of which can cause lengthy pump-down cycles until thoroughly outgassed. More recently, a strippable organic film that can be applied to the inside of the clean tank has been introduced. When it is desired to remove the accumulation of evaporated metal, the flexible coating is peeled from the inside of the tank and a new coating applied.

In setting up the metalizing operation, provision should also be made for applying base and topcoats, as well as for baking or airblast-drying facilities. Lacquers may be applied by hand spray, automatic spray, electrostatic spray, dipping, or flow coating processes.

As in any organic finishing operation, the complexity and cost of the installation must be matched against the character of the parts to be coated and the production levels required. In the metalizing operation complete exclusion of channels, tears, and orange peel effects is particularly important, because the application of a highly reflective metallic film to imperfections serves to magnify them. Flow coating is popular because of the high-quality finishes it provides and the economics offered by the minimized finish losses. Similar requirements pertain to the top-coating operation. Conventional baking or dry-air-circulating ovens are required depending upon the nature of the base material and the types of finishes employed. Base coats in particular must be thoroughly baked or dried out to minimize evaporation and out-gassing of solvents when the coated part is introduced into the metalizing chamber for processing.

Continuous roll metalizing

In the continuous metalizing process, a roll of plastic, e.g., polyester film, acetate, styrene,

etc., is traversed across a source of continuously vaporizing aluminum. Webs up to 60 in. wide, traveling at several hundred linear ft./min., thus receive a brilliant metallic finish. After metalizing, the film or sheet is then rewound on a take-up roll.

Shapes die-cut from metalized plastics film or sheet may be used as labels or sequins in decorative applications. Considerable activity has also taken place in vacuum formed metalized materials for the sign and display field. Fashion applications include coverings for wallets and shoes, and a decorative textile yarn made from metalized polyester film slit into narrow widths. Metalized polyester film can also be laminated to heavier vinyl sheeting and embossed to produce a product which will be decorative.

Cathodic sputtering

Cathodic sputtering is very similar in operation to vacuum evaporating, except that the pressure required is not as low. Also, the metal is applied by producing a high-voltage differential between the source and the object to be coated, rather than by heating. The metal to be deposited serves as the cathode. Under the influence of a high voltage, metal atoms leave the cathode and are deposited on nearby surfaces.

The resultant coat is similar in appearance to that obtained by vacuum evaporation, but the rate of application is much slower (rates of deposition by sputtering limit the film speed to about 20 ft./min.).

Applications are generally confined to precious metals or where closely controlled, extremely thin films are desired. Aluminum can not be sputtered.

Electroplating†

Very often, it is desirable to build up a heavier deposit of metal on plastics surfaces than can be obtained with conventional processes. In such instances, electroplating is used.

Successfully to electroplate a layer of copper on a vacuum metalized film of copper, certain precautions must be taken. The usual procedure for normal electroplating of metal parts calls for a few seconds of "back flash" before the plating actually begins. This "back flash" is a cleaning operation which removes a slight layer of metal oxide from the surface of the object to be plated. It is done by reversing the current for a few seconds, thereby making the object to be plated the anode instead of the cathode. In plating, the D.C. current flows from the anode to the cathode and the metal builds up on the cathode. During the "back flash" cleaning operation, the cathode (which is the anode during "back flash") will be stripped of a thin layer of metal. Thus, this operation cannot be performed on a vacuum metalized film.

For electroplating on a thin, evaporated film, a common copper sulfate plating bath, slightly on the acid side, should be used. The temperature of the bath should be between 90 and 100° F. A voltage of 7½ v. and a current of 50 amps/sq. ft. (0.35 amps/sq. in.) should be used. This rating will deposit about 0.0025 in. per hour. If higher current is used, burned-out areas will be created in the vacuum metalized film.

Chemical reduction

There are many different techniques, solutions, and sensitizing agents for use in the chemical reduction method. In this type of metalizing, a chemical compound is reduced to metal. This is not a simple operation, and must be carefully controlled.

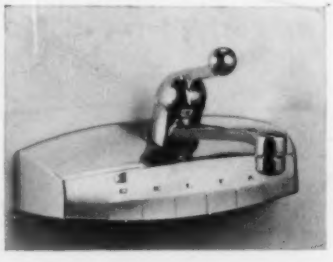
The chemical reduction method is attractive to companies which require a special "softer" finish, and a more perfect duplication of gold or silver than is obtained by dyeing evaporated, coated aluminum.

The seven basic steps required in the reduction techniques are: 1) degreasing; 2) rinsing in fresh water and drying; 3) sizing with a thin coat of lacquer and baking dry; 4) sensitizing, then flushing with fresh water and drying; 5) silvering, by reduction, then flushing again with fresh water and drying; 6) coating with lacquer and baking dry; and 7) dyeing to the required color and drying.

The most important precaution to be observed in each of these steps is that the pieces should not be allowed to come in contact with any foreign objects which might deposit a thin film of grease or oil on them. Special holding fixtures must be designed and clean, lint-free gloves worn.

Mold lubricants are deadly to all metalizing processes and must be completely removed.

Clear plastic trim for sink faucet is metalized on second surface to match appearance of polished chrome plate



Metal inlaying

There are several patented processes for inlaying metal in transparent or opaque plastics.

Most common is the four-step process used for a *surface inlay*. A recess of appropriate shape is formed in the plastics object, either during the molding operation or by subsequent engraving. A thin strip of hard metal, about half as thick as the depth of the recess, is placed in the bottom of the recess. A slightly curved metal inlay is placed on the hard base metal strip, concave side down. Pressure is applied to the convex top of the inlay, and, because the hard base metal has more resistance to the pressure than either the inlay or the plastics, the inlay is forced to spread out on the sides, penetrating the walls of the recess and permanently locking itself in place.

The *reverse inlay* is a patented process used with transparent plastics. A cavity molded in the back of the piece receives a two-layer metal inlay. If the first piece is stenciled, an effective design can be obtained by using a contrasting second piece. An etched or lithographed design is also possible. The design may be

† Paragraphs on Electroplating, Chemical Reduction, and Metal Inlaying prepared by J. Gordon Seiter, Mgr., High Vacuum Div., F. J. Stokes Machine Co.

inlaid in duplicate so that it can be seen from both sides. If the sides of the cavity are specially formed, the effect is that of a series of planes.

Another inlay process is the *foldover*, in which the plastic part is molded with an excess of material around the edge of the cavity. After the inlay has been inserted, it is anchored in place by softening the excess material and forcing it over the edges of the inlay. The *sandwich* process uses two pieces of plastic, one opaque and one transparent. The inlay is placed in a recess in the opaque piece and the transparent piece is then bonded to the opaque surface.

References

For further information on decorating plastics materials, see p. 828.

"A challenge to junior," MODERN PLASTICS *31*, 148 (June 1954).

"Metalized butyrate reflectors," MODERN PLASTICS *30*, 110 (March 1953).

"Vacuum metalizing of plastic sheet," MODERN PLASTICS *31*, 122 (Dec. 1953).

"Plastics *vs.* die casting," Plastics (London) *17*, (Aug. 1952).

"High vacuum metalizing," by A. H. Hartman, MODERN PLASTICS *30*, 115 (Oct. 1952).

"Molded plastics plus precious metals," by Jack B. Loeffler, MODERN PLASTICS *30*, 92 (Dec. 1952).

"Vacuum metalizing as a design tool," by J. C. Seiter, Electrical Manufacturing *50*, 148-9, 334, 336 (Nov. 1952).

"Vacuum metalizing in the plastics industry," by J. C. Seiter, SPE Journal *8*, 12-13 (October 1952).

"The metalization of plastics," by Dr. Harold Narcus, SPE J. *9*, 26 (March 1953).

"Silvering of plastics," K. S. Low, Brit. Plastics *26*, 457-60 (Dec. 1953).

WELDING PLASTICS

BY J. A. NEUMANN* and F. J. BOCKHOFF†

Recent Development

Greater versatility and easier handling are the attributes claimed by the manufacturer for the new Model P hot-gas plastic welder. Heating elements are extra sturdy; standard heater delivers 320 w., but heaters of 180, 240, and 600 w. are available on request. Elements can be changed in a few minutes and the range of wattages permits the safe welding of all thermoplastics from thin polyethylene to thick PVC. A molded plastics handle gives both better grip and better insulation than handles of earlier models. *Seelye Craftsmen, 984 Central Ave., Minneapolis, Minn.*

The adaptability of the hot-gas welding technique (1, 2, 3)[1] allows the fabrication of almost any type or size of process equipment. Large forms can be joined and extended to form duct work, exhaust systems, reactor tanks, and pipe lines, as well as tank liners.

In order to be weldable, a thermoplastic must possess a reasonable melting range rather than a sharp melting point. A melting range is important in allowing control of the welding process.

Most of the thermoplastics can be welded. Polyethylene and polyvinyl chloride are particularly adaptable to welding and these materials are used to the greatest extent.

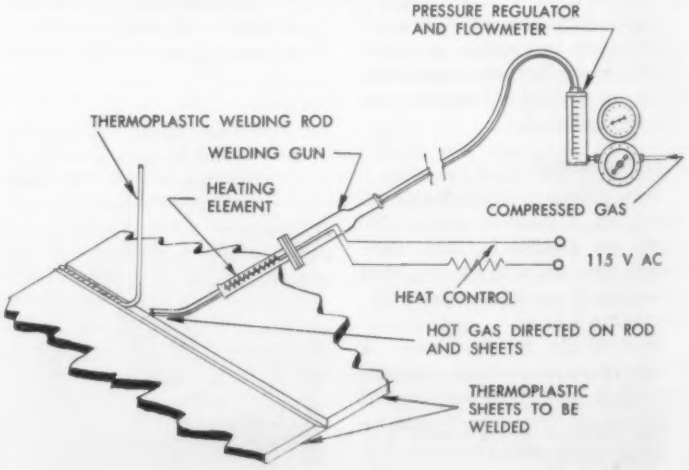
The newer linear or high-density polyethylenes can be hot-gas welded to produce joints of satisfactory strength. In addition, saran, polyacrylic esters, and fluorothene are among the plastics materials that have been successfully welded.

Technique

Basic thermoplastic forms such as sheet, rod, extruded tubing, centrifugally-cast tubing, and welding spline are commercially available in a large variety of sizes and materials. These forms are subsequently joined by welding to produce most finished fabrication.

A schematic diagram of the general welding technique is illustrated in Fig. 1, below. Heated gas from the welding gun is used to join the components to be welded, using a rod of the same composition. Compressed air is used for many plastics, particularly the rigid vinyls. When welding polyethylene, however, an inert gas such as nitrogen is usually used to prevent any possible surface oxidation which

Fig. 1: Diagram showing the components and a typical arrangement used in the plastics welding process. Heated gas from the welding gun is used to join components together. (Sketch, American Agile Corp.)



* President, American Agile Corp., P. O. Box 168, Bedford, Ohio.
† Asst. Professor, Chemical Engineering, Fenn College, Cleveland, Ohio.
[1] Numbers in parentheses link to References on page 842.
Recent Development was prepared by the editors.

may produce faulty bonding. As the surface of the rod and sheet are softened, the filler rod is continually forced into the weld bed under slight pressure. Unlike metal welding, complete fusion does not take place. Although it is important that the exterior of the welding rod be soft in the case of polyvinyl chloride or transparent in the case of polyethylene, it is also important to maintain rigidity of the rod core in order to maintain proper weld control.

Both electrically-heated and gas-heated welding guns are available. The schematic diagrams of both types are shown in Fig. 2, right. Several gun tips are available in straight and curved form, depending upon the operator's preference. Usual orifice temperature in welding varies from 400 to 600° F. and is controlled by regulating the current to the heating unit in the electric gun or by varying gas pressure and flow rate. Normal gas pressure varies from 5 to 15 p.s.i.g. and optimum flow rate for most welding is approximately 2 cu. ft./minute. The distance between the tip of the gun and the weld bed usually varies between 1 and 2 in. and within this distance a temperature drop of about 200° F. is experienced. Linear welding speeds of from 5 to 8 in./min. are commonly realized. The welding speed is dependent upon both the type of weld and the skill of the worker operating the gun.

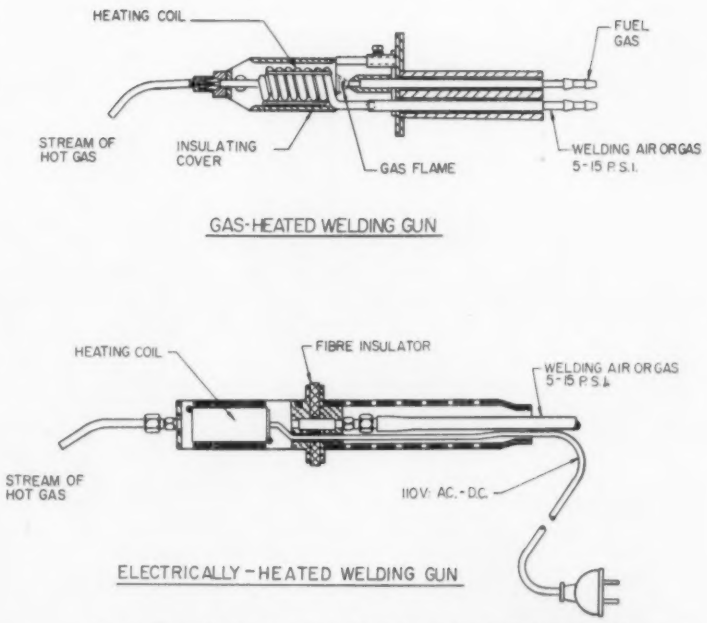


Fig. 2: Schematic drawings of gas-heated and electrically-heated welding guns. Orifice temperatures are controlled by varying gas pressure and flow rate (in gas-heated gun) or by regulating current (in electrically-heated gun)

Bonded strength

As is true for all bonding and welding, bond strength is improved by a proper preparation of surfaces to be joined. When making a butt-weld, the edges to be joined should be beveled to include an angle of 60°. When lap-welding and fillet-welding, the surfaces to be joined should be solvent-cleaned or mechanically roughened. Generally, solvent-cleaning alone is satisfactory for the preparation of fillet-welds.

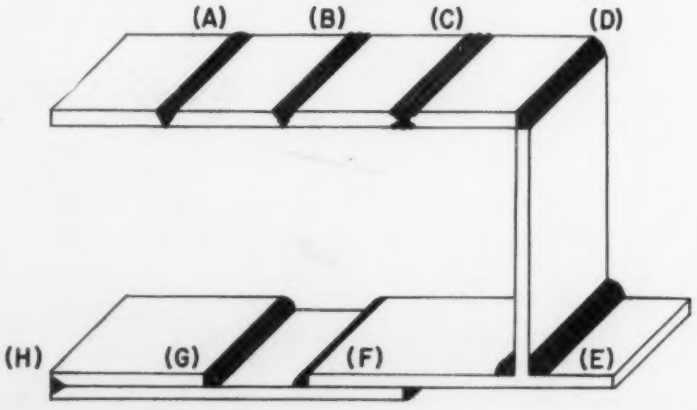
It is important that any of the lubricants or mold release agents used in the fabrication of basic components be removed completely from the surface before beginning to weld. Several weld types are illustrated in Fig. 3, below.

The correct angle between filler rod and weld bed varies with the type of material being welded. Fig. 4, p. 840, illustrates the welding of polyethylene in which the rod is turned to an obtuse angle in order to exert sufficient bonding pressure on the fused surfaces. In the case of more rigid materials such as linear polyethylene and nonplasticized polyvinyl chloride the rod is held at approximately 90° to the weld as shown in Fig. 5, p. 841. A perpendicular filler-rod angle is used with all rigid thermoplastics.

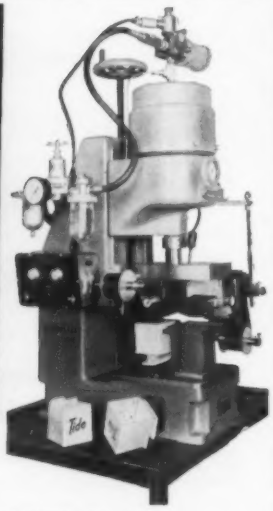
Testing methods

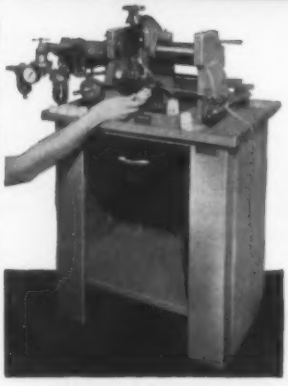
The strength of a weld is given in terms of a weld value which compares the breaking stress of

Fig. 3: Six basic weld types: A) single-bead, single-V butt weld; B) multiple-bead single-V butt weld; C) multiple-bead double-V butt weld; D) corner weld; E) double fillet weld; F) lap weld; G) lap-bead; and H) edge weld. Each type requires special surface preparation, e.g., beveling, solvent cleaning, etc.



THE LAST WORD IN HOT STAMPING MACHINES





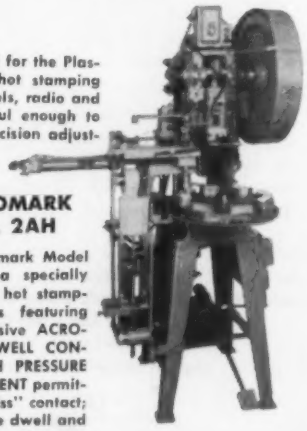
ACROMARK No. 250

The latest improved, flat bed type of Hot Stamping Press. This Acroleaf Press has up to a 6" x 6" die area, and 6" roll-leaf width, mouth 9½" and throat 8" deep, all within 370 lbs. not including dies and controls.

Fully adjustable, sturdy construction, air operated, automatic temperature control and Acroleaf feed. FOR GENERAL PURPOSE WORK. May be easily tooled for SPECIAL jobs. For example—above application requiring INSIDE and OUTSIDE imprinting, was done at one stroke. Several standard sizes are available.

ACROMARK No. 9AH

THE general purpose marking machine designed for the Plastics Industry and THE ACCEPTED STANDARD hot stamping machine for peripheral marking of counter-wheels, radio and TV controls and all cylindrical work is powerful enough to mark steel and cast iron continuously while precision adjustments permit "kiss" imprints on the most delicate thermoplastics. Both bevel edge and straight controls are accurately and quickly hot stamped completely around the circumference at one loading. The work is accurately held and independently gear driven in proper registry with the engraved marking die. Automatic Acroleaf feed, temperature control, and speed control is standard on 3 stock models with automatic cycling, two-color set-ups, etc. available on special order.



ACROMARK No. 2AH

The Acromark Model 2AH is a specially designed hot stamping press featuring the exclusive ACROMARK DWELL CONTROL and PRESSURE ADJUSTMENT permitting a "kiss" contact; adjustable dwell and then full pressure.

This machine should not be confused with a standard power press to which hot stamping attachments have been added.

MADE only in Elizabeth, N.J.

For "the last word in hot stamping machines", write for catalog of series specified and send drawings or samples of products to be marked indicating daily production needed. Indicate Series 250, 9AH or 2AH. Representatives in most industrial areas.

ACROMARK

THE ACROMARK COMPANY

5-15 MORRELL ST., ELIZABETH, NEW JERSEY

"The Original Marking Specialists"



Fig. 4: Rod is turned to an obtuse angle in laying a polyethylene butt weld. (Photo, American Agile Corp.)

a welded specimen to the ultimate tensile strength of the parent material:

$$W = \frac{S_w}{S_p} \times 100$$

where: W = weld value (%); S_w = break stress on the weld (p.s.i.); and S_p = ultimate tensile strength of the parent material (p.s.i.)

Branched polyethylene welds show strengths varying from 95 to 100 percent. Linear polyethylene exhibits lower weld values, in the neighborhood of 50 to 60 percent. It must be remembered, however, that the actual break stress of the weld is still higher than that of a branched polyethylene weld, due to the much higher ultimate tensile strength of the parent linear polyethylene. Here, the actual weld value is deceptive unless one is also familiar with the ultimate tensile strength of the parent material. Polyvinyl chloride welds exhibit weld values in the range of 75 to 90 percent.

The weld value of a crystalline material such as polyethylene varies considerably with the molecular structure of the basic polymer. Weld value usually increases with increasing molecular weight and also increases with increased molecular chain branching or decreasing crystallinity. It must also be pointed out that the weld strength of a crystalline polymer such as polyethylene is a function of time and usually increases exponentially from the time at which the weld is completed.

This gradual increase in the

weld strength with time is due to the reorientation of the molecular structure as it approaches crystalline equilibrium. With branched polyethylene welds, maximum strength is reached within 4 hours. The quality of a weld has also been shown to be dependent to a large extent upon the skill of the operator (4).

Ineffective welds can be produced if air is occluded while laying the filler beads. Air occlusions can usually be observed in natural polyethylene by the use of a strong inspection light held at an oblique angle in relation to the weld.

Minute cracks and pores in welded seams are often detected by spark testing. This is particularly useful for the examination of tank-liner welds, since a steel supporting tank serves as a good electrical ground.

Radiography has also been used successfully for locating defects in plastics welds (5). This is particularly useful and efficient in checking welds within closed assemblies such as welded globe valves.

Applications

Practically any equipment that can be fabricated from steel can be made from plastics. The basic nature of the welding technique allows the fabrication of large-size structures. A pulse extraction column, for example, measuring 10 ft. high and 20 in. in diameter, has been completely fabricated of polyethylene, using the hot-gas welding technique. The wall thickness of the poly-

Fig. 5: Rod is held at a 90° angle in making a butt weld in nonplasticized polyvinyl chloride material. (Photo, American Agile)



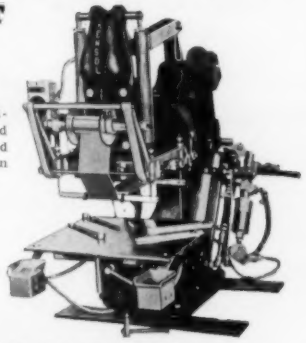
Solve your Plastic Marking problems

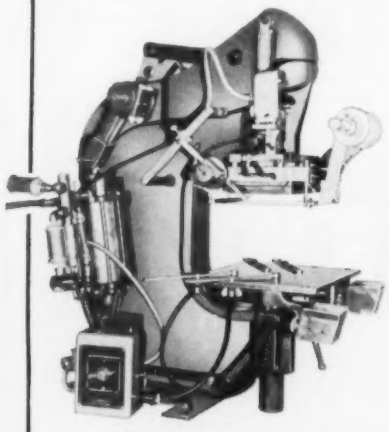
with KENSOL Hot Stamping Presses

Kensol 35T

AIR-OPERATED POWER PRESS
for items up to 2 ¼ inches high

A ruggedly constructed, air-operated, electrically dwell-timed power press with 4 x 8 inch imprinting area and a 3 inch head stroke. Also available as a hand operated press which can be later converted to power in your own plant. Weighs 280 pounds.





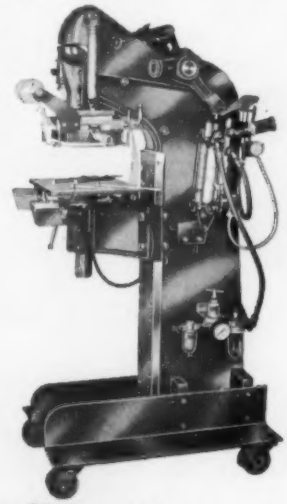
NEW Kensol 60
HEAVY-DUTY POWER PRESS
for items up to 5½ inches high

A completely new Kensol model available with one or two main cylinders. When equipped with two cylinders, extremely high pressures are developed to stamp work well out of the range of air-operated equipment previously available. Press has 3 inch head stroke, and is available with 6 x 8, 9 x 12 and special impression areas up to 24 inches wide. Weighs 490 pounds.

NEW Kensol 110
HEAVY-DUTY POWER PRESS
for items up to 24 inches high

A completely new Kensol model available with one or two main cylinders. Bed can be lowered to accommodate large plastic pieces (refrigerator parts, radio cabinets, etc.) up to 24 inches high. When equipped with casters, the g110 can be rolled up to molding machines, etc. Weighs 650 pounds.

Send for complete information. Literature on all Kensol equipment will be sent on request. Included will be information on large size roll leaf attachments, Kensol g20 turntable attachment, power sliding table, automatic feeding devices and other pertinent information.



and OLSENMARK Roll Leaf

Send for Color Chart which shows actual color stampings of the complete line of Olsenmark Roll Leaf. Fine quality, economically priced Olsenmark Roll Leaf is available in pure gold, imitation gold and silver, and all popular colors including luster colors which print with a high gloss.

SINCE 1924
OLSENMARK Corporation

124-132 WHITE STREET, NEW YORK 13, N. Y.

Specialists in Quality Marking Equipment and Supplies for over 30 years



☐ **Thin kerf?**

Forrest blades save materials with 1/32" saw kerfs when applicable.

☐ **Long blade life?**

Forrest carbide tipped blades give up to 50% longer cutting life between sharpenings than regular carbide blades, and have up to 20 times longer cutting life than ordinary steel blades.

☐ **Smooth cutting?**

Forrest blades are precision tools, custom ground with a micro-finish to assure chip-free and splinter-free cutting on such plastic materials as acrylic, styrene, polyethylene, urea, laminates, printed circuits.

Write for illustrated brochure and for price lists.

Forrest

MANUFACTURING COMPANY, INC.

P.O. Box 189—231 Highway 17, Rutherford, N. J.

"YOU CAN TELL A FORREST BLADE BY ITS CUT"



ethylene sheet used for the application was 5/16 inch. Separation plates were fabricated of 1/2 in-thick polyethylene sheet.

Hot-gas welding also provides a positive and economical means for the fabrication of small items of a short-run nature, such as polyethylene laboratory tanks.

Actual applications are discussed extensively in available literature (6, 7).

Conclusion

Hot-gas welding is a sure and quick method of joining plastics with optimum strength. Great strides are presently being made in the development of automatic welding machines to produce consistently good welds in 25% of the time ordinarily required for manual welding.

More and more plant engineers are discovering the applicability of welded plastics and are installing replacements and fabrications with these materials. In addition, plastics-welding maintenance departments are being initiated to a greater extent to accommodate the demand of process industry for the trouble-free performance provided by corrosion-resistant plastics equipment.

References

1. Neumann, J. A., "Hot-gas welding of plastics," Modern Plastics *28*, 97 (Nov. 1950).
2. Stanley, E. C., and Stilton, H. R., "Progress in Plastic Sheet Welding," Plastics (London) *19*, 72-75 (March 1954).
3. Huscher, J. L., "Fabrication and Use of Rigid Polyvinyl Chloride Plastics," Materials and Methods *39*, 119-34 (June 1954).
4. Bockhoff, F. J., and Neumann, J. A., "Testing for defects in polyethylene welds," Modern Plastics *32*, No. 2, 150 (1954).
5. Neumann, J. A., and Bockhoff, F. J., "X-ray Inspection Methods in Plastics Fabrication," Plastics Technology *1*, No. 2, 87 (1955).
6. Bockhoff, F. J., and Roth, R. F., "Plastics for Chemical Engineering Construction," Chem. Eng. Progress *51*, No. 6, 251 (1955).
7. Neumann, J. A., and Bockhoff, F. J., "Plastics for Vessels," Ind. Eng. Chem. *47*, No. 7, 1328 (1955).

Want to

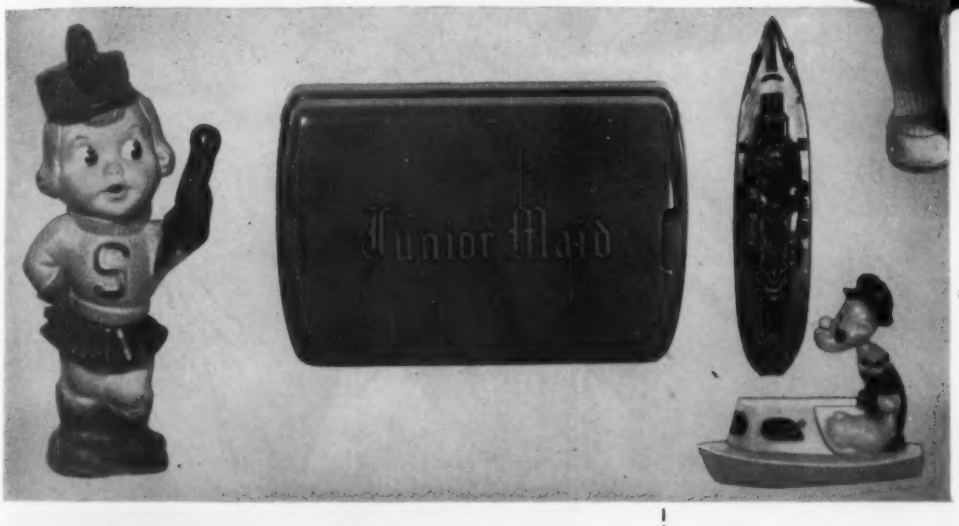
cut your printing costs?

step up your production?

use inexperienced help?

FIORE SPRAY MASKS
are the answer





©Walt Disney Productions

No paint job is too complicated for a Fiore spray mask.

No matter how intricate the painted detail on your product, Fiore can design a spray mask that will give you exact registration—even on irregular and contoured surfaces.

Every Fiore mask is made by the electroforming process, to insure accurate reproduction of even the finest detail, including a great variety of products—such as name plates, toys, novelties and displays. Fiore has also developed a special technique for those hard-to-handle spots, including doll's eyelashes.

MASK FIXTURES

Fiore also makes jigs and fixtures to enable sprayers to place masks in exactly the right position, with a minimum of time and effort.



In this illustrated booklet you'll find a thorough account of the Fiore method. Write for your FREE copy, and find out how you can improve your spraying operations.

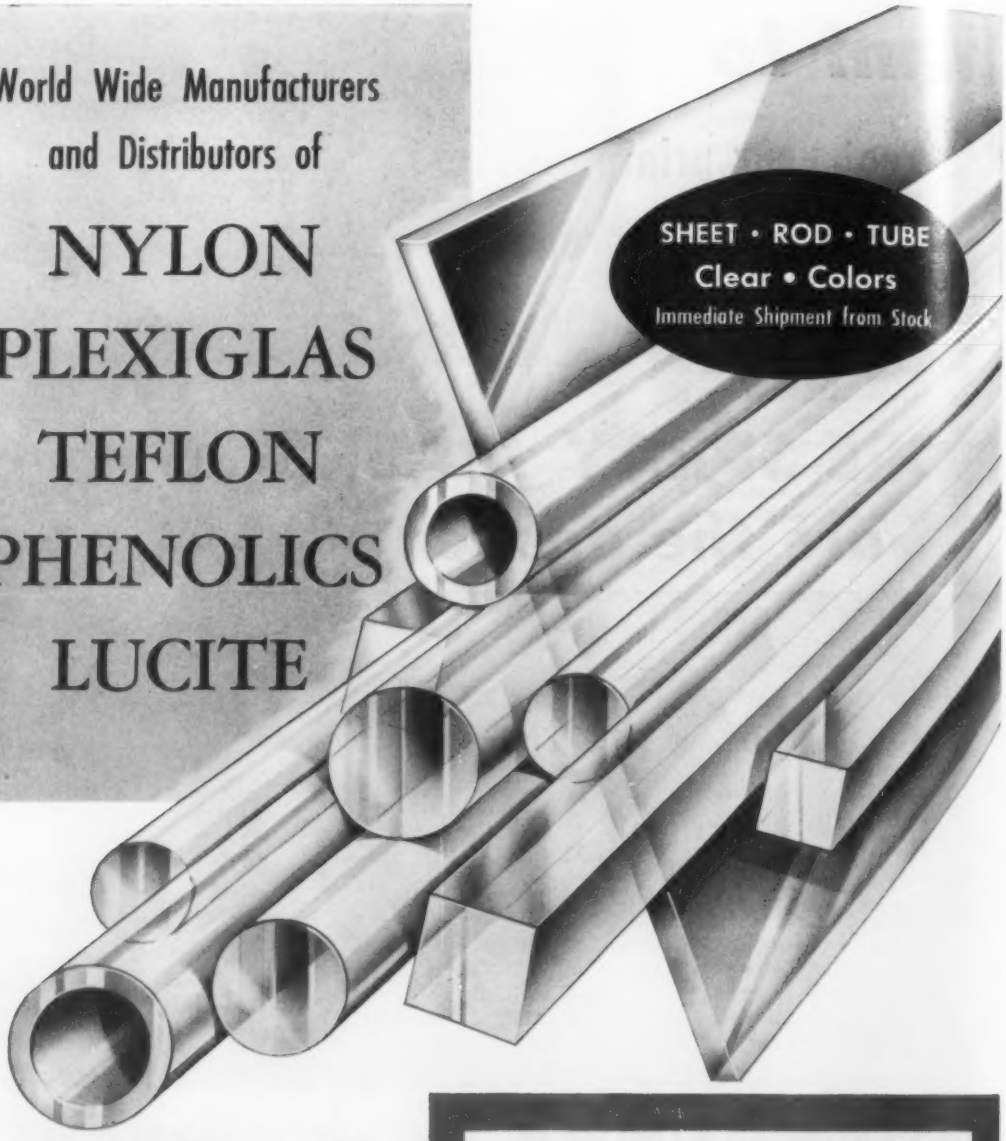
WM. M. FIORE INC.

269 41st St., Brooklyn 32, N. Y.

World Wide Manufacturers
and Distributors of

NYLON
PLEXIGLAS
TEFLON
PHENOLICS
LUCITE

SHEET • ROD • TUBE
Clear • Colors
Immediate Shipment from Stock



Suppliers of the following plastic materials

Nylon	Polyethylene	Lucite
Phenolic	Polystyrene	Rexolite
Teflon	Fibre	Catalin
Acetate	Mycalex	Tensilite
Kel-F	Hard Rubber	Casein
	Plexiglas	

Parts and electrical insulators fabricated to specifications from any material you select





Send for prices, information and catalog

2232 West Armitage Ave., Chicago, Ill. CApital 7-0300

Colonial Kolonite Co.

311 N. E. Buckhead St., Atlanta 5, Georgia

529 S. 7th St., Minneapolis 15, Minnesota

210 Heights-Rockefeller Bldg., Cleveland 18, Ohio

2702 North Avenue, Anderson, South Carolina

AUTOMATIC EDGING of SPHERICAL MOLDINGS

NASH 103 AUTOMATIC FLASH LATHE

(Continuous Turret Operation)

A Ten Spindle Machine . . . produces up to 90 pieces per minute

Automatic removal of parting line flash using spring loaded file flashing units or special tooling. Accommodates diameters up to 4½" . . . height adjustment up to 8". Uniform results, confines flash removal to minimum line.



NASH 103-B AUTOMATIC FLASH LATHE

(Intermittent Motion on Turret)

For Finishing Operations On Moldings That Require Controlled Index and Stop, At Working Stations



Tooling can be provided for cutting, belt abrasive action, buffing, etc. Full control on rate of index, gradual approach to tooling and metered time at stop position.

Table arrangement to mount a variety of tooling performing successive operations on the moldings.



NASH 116 ROTARY EDGER

. . . for the edging of plastic dinnerware

Four motor-driven belt units remove parting line flash and buff-edge without destroying contour. Will accommodate plates up to 11½", variable rate of production from 10 to 30 pieces per minute.

Produces proper finishing results superior to hand methods at fraction of finishing cost. The standard machine for the edging of plastic dinnerware.

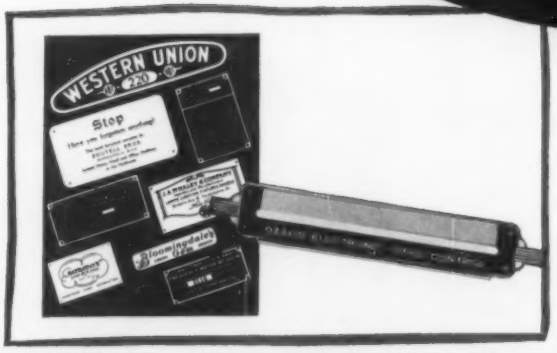
We will be pleased to work with you on your finishing problems and make the correct machine recommendation on the basis of samples or prints you furnish.

FULL DESCRIPTIVE LITERATURE

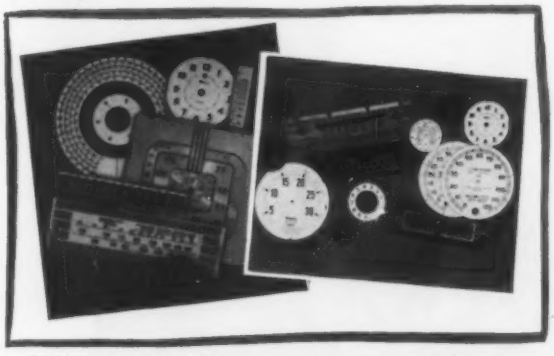
J. M. NASH COMPANY

2373 NORTH 30th STREET **MILWAUKEE, WISCONSIN**

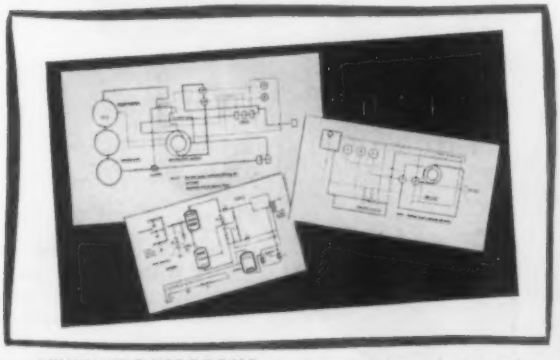
HOW Sillcocks-Miller CAN HELP YOU WITH PRECISION-FABRICATED PLASTICS



NAMEPLATES . . . Distinctive identification fabricated of the right plastic to resist temperature and weather and protect your message.



DIALS . . . Fabricated to close tolerances and formed to any shape to meet your individual needs.



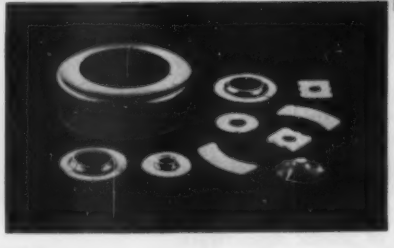
SCHEMATIC DIAGRAMS . . . Reproduced on plastics and laminated for sharp definition, clean appearance and durability.

Since 1910, Sillcocks-Miller has specialized in the precision-fabrication of plastics. This long experience is available to give your products the practical advantages of the plastic material best-suited to your requirements. The latest techniques are combined with complete facilities for cutting, printing, stamping, cementing, milling, turning, blanking, drawing, forming, laminating and assembly. Send your specifications for recommendations and quotations.

SAVE ON MOLD COSTS for Small Parts!

A special fabricating process developed by Sillcocks-Miller engineers saves on cost of molds for small parts, such as insulators and washers. You get this saving without sacrifice of quality or service life. Write for details and recommendation.

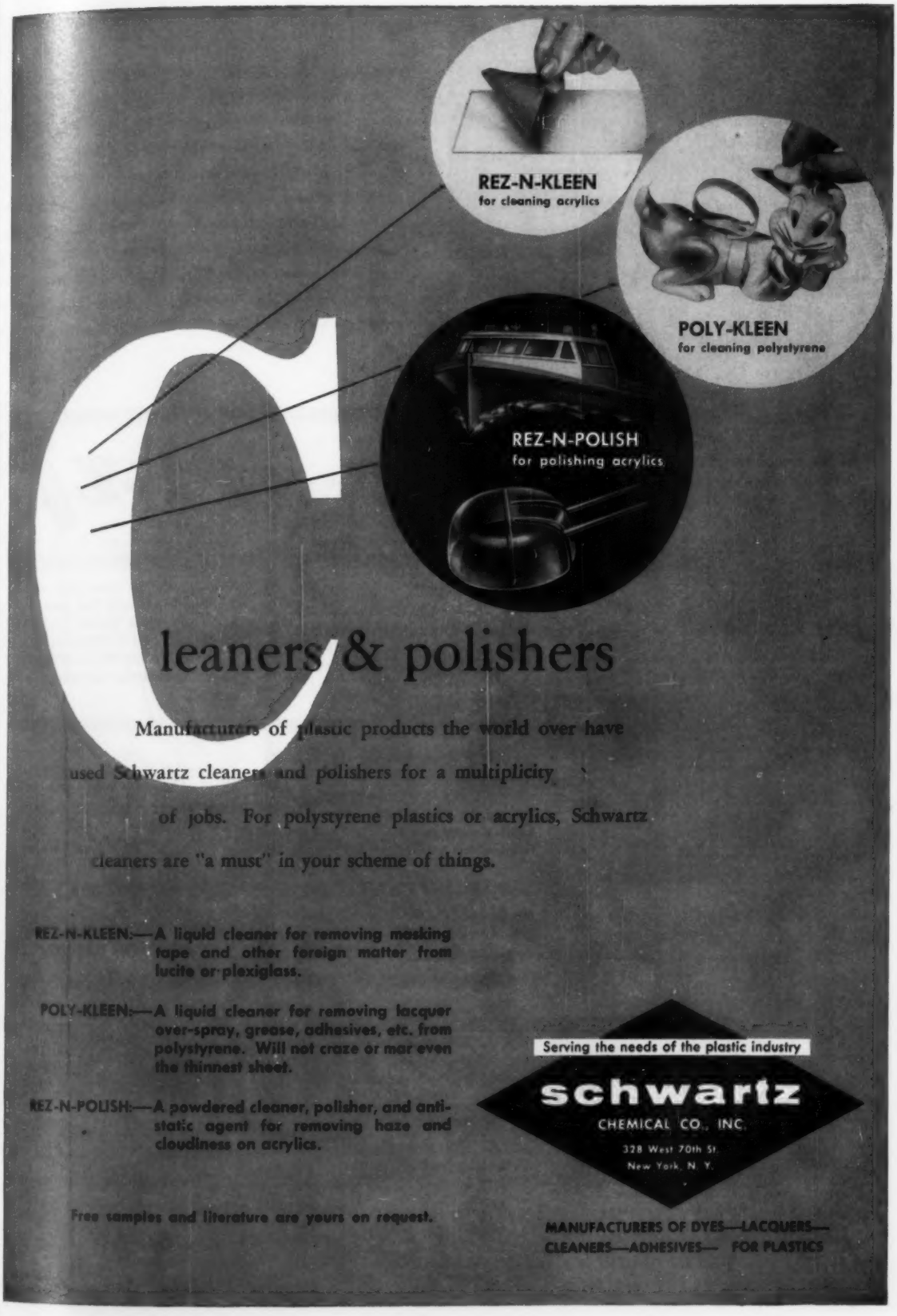




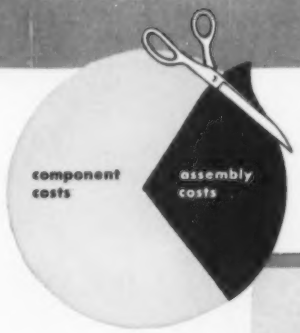
The SILLCOCKS-MILLER Company

10 West Parker Avenue
Maplewood, New Jersey

PIONEERS IN THE PRECISION FABRICATION OF PLASTICS SINCE 1910


REZ-N-KLEEN
for cleaning acrylics
POLY-KLEEN
for cleaning polystyrene
REZ-N-POLISH
for polishing acrylics
Cleaners & polishers
Manufacturers of plastic products the world over have used Schwartz cleaners and polishers for a multiplicity of jobs. For polystyrene plastics or acrylics, Schwartz cleaners are "a must" in your scheme of things.
REZ-N-KLEEN:—A liquid cleaner for removing masking tape and other foreign matter from lucite or plexiglass.
POLY-KLEEN:—A liquid cleaner for removing lacquer over-spray, grease, adhesives, etc. from polystyrene. Will not craze or mar even the thinnest sheet.
REZ-N-POLISH:—A powdered cleaner, polisher, and anti-static agent for removing haze and cloudiness on acrylics.
Free samples and literature are yours on request.
Serving the needs of the plastic industry
schwartz
CHEMICAL CO., INC.
328 West 70th St.
New York, N. Y.
MANUFACTURERS OF DYES—LACQUERS—
CLEANERS—ADHESIVES— FOR PLASTICS

plan fastenings to trim ASSEMBLY'S "BITE" IN PRODUCTION COSTS



Assembly's percentage of total production cost runs from 10% or less in simple "gadgets" to as much as 75% in modern aircraft. There is no room for needless assembly expense in any product.

In 7 out of 10 products surveyed for applications, the P-K Fastening Method has proved simplest and speediest. You eliminate the extra cost of tapping for machine screws, and the expensive and troublesome inserts that slow up molding. Assembly *starts* several steps closer to the finished job. And, fastenings are stronger, more resistant to vibration.

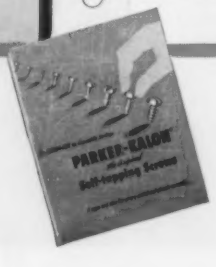
PLAN BETTER PLASTICS ASSEMBLIES WITH THESE P-K AIDS

ASSEMBLY ENGINEERING SERVICE P-K Assembly Engineers are fastening experts who are ready to work with you and point out how to save operations, simplify assemblies, and add product strength. Since P-K offers a complete line of Self-tapping Screws, recommendations are unbiased. The P-K method fits the right screw to the job. A P-K Assembly Engineer will call at your request.

TECHNICAL LITERATURE Parker-Kalon has prepared useful information in several forms to assist you in planning assemblies. Some are shown below. Write for the ones you need.

	Type Z* HEX HEAD Z*	Type F-Z
types	TYPE Z ALSO MADE WITH PHILLIPS HEAD	ALSO MADE WITH PHILLIPS HEAD
uses	Primarily used for fastenings in cellulose acetate and nitrate compounds, polystyrenes, and laminated phenolics. Forms thread as it is driven. Can be removed and replaced.	Primarily used for fastenings to comparatively thin sections and bosses in friable and brittle plastics. Combines coarse pitch thread advantages of Type Z with thread cutting features of Type F. Five cutting flutes. Can be removed and replaced.
metals	Standard screws are hardened steel. Available with any plated or other finishes in common use. Stainless Steel (18-8) Type Z (not Hex Head) are also standard in some sizes. Furnished on special order in Type 410 corrosion resistant Steel, hardened.	Hardened steel, available with any plated or other finishes in common use. Also Type 410 corrosion resistant Steel, hardened. Type F-Z is not stocked, but is available on special order.
head styles	Standard head styles are Round, Binding, Stove, Flat, and Oval, as well as Hex Head shown above.	Available with Round, Binding, Flat, Oval, or Hex Head.
special forms	 (illust.) Non-standard forms of Type Z can be developed and furnished on special order. Typical modifications are illustrated.	 (illust.) Special forms of Type F-Z can be developed and furnished to order. Typical modifications are illustrated.

P-K Self-tapping Screw Bulletin
48 pages, describes all types, tells where and how to use what screw, shows many plastics applications. Ask for Form 430.



P-K Engineering Standards
64 pages, gives standard head and thread dimensions of all P-K Screws, other useful data. Ask for Form 600A.

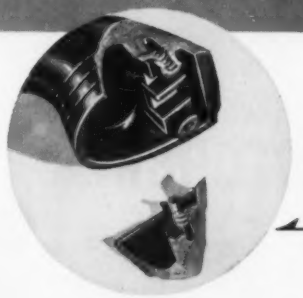


*A. S. A. Designation — Type B

When you have planned assembly savings, make sure they *pay off* on the assembly line by specifying *P-K* Self-tapping Screws. The originator and largest manufacturer, Parker-Kalon has learned through long experience how to provide the proper combination of hardness and toughness, the sharp threads and accurate size, the consistent dependability that avoids spoiled parts and keeps assembly trouble-free.

Try P-K Screws. You'll agree "If it's P-K, it's O.K." Parker-Kalon Division, General American Transportation Corporation, Clifton, N. J.

specify P-K to be sure PLANNED SAVINGS WILL PAY OFF



the molder was blamed

When "tough breaks" like this occur, the custom molder is usually blamed. But the fault was in choosing the wrong type of fastener. That's why so many molders get recommendations *first* from Parker-Kalon.

Type F	Type U
ALSO MADE WITH PHILLIPS HEAD	
Primarily used for fastenings in crumbly and friable materials, in phenolic and urea base compounds, cold mold compositions, and hard rubber. Cuts thread as it is turned in. Can be removed and replaced.	For permanent fastenings. A hardened drive screw, it is hammered or pressed in, forming its own thread. Suitable for all types of plastics. Can be driven rapidly with hopper-fed machines. Cannot be removed.
Standard screws are hardened steel, available with any plated or other finishes in common use. Furnished on special order in Type 410 corrosion resistant Steel, hardened.	Standard screws are hardened steel, available with any plated or other finishes in common use. Furnished on special order in Type 410 corrosion resistant Steel, hardened.
Standard head styles are Round, Binding, Flat, Oval, and Hex.	Standard head style is Round only. Other head styles on special order.
(illust.) Non-standard forms of Type F can be developed and furnished to order. Typical modifications are illustrated.	(illust.) Non-standard forms of Type U can be developed and furnished to special order. Typical modifications are illustrated.

P-K Self-tapping Screws are used in thousands of the nation's best-known products for fastenings to the following plastics:

PHENOL FORMALDEHYDE
Molded: Bakelite, Durez, etc.
Cast: Catalyn, etc.
Laminated: Formica, Textolite, etc.

UREA FORMALDEHYDE
Molded: Plaskon, Beetle, etc.

CELLULOSE ACETATES & CELLULOSE NITRATES:
Tenite, Lumarith, Plastacele, Celluloid, Pyralin, etc.

ACRYLATE and STYRENE RESINS:
Lucite, Plexiglas, Styron, etc.

PLYWOOD, Resin Impregnated
Compreg, Pregwood, etc.

IF IT'S P-K IT'S O.K.

P-K Users' Guide
Plastic bound, index-tabbed work-book of technical information on selection and application of P-K Screws. Popular with designers and engineers, and draftsmen for quick reference. Ask for Form 479C.



PARKER-KALON®

The Original
SELF-TAPPING SCREWS

PLASTIC-WELDING





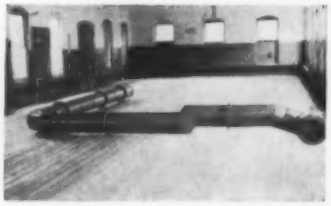
NEW LIGHTWEIGHT MODEL



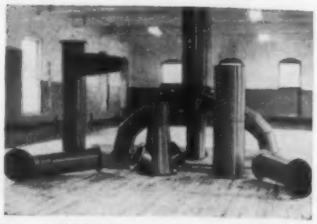
TORCHES

D&R PLASTIC WELDERS, INC. D&R HAZARDVILLE, CONN.

FABRICATING





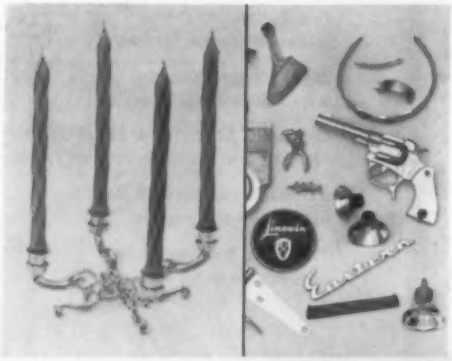


D & R PLASTIC WELDERS, INC.

HAZARDVILLE, BOX J CONNECTICUT

Get Started Easily

IN VACUUM COATING

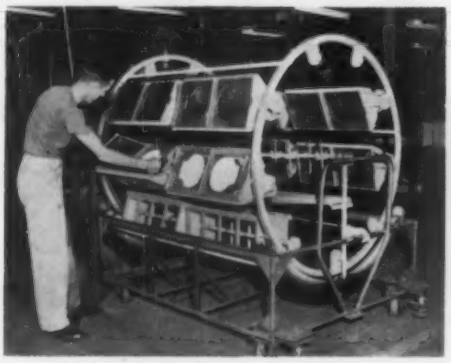


Vacuum coating can help you open up new markets by adding a quality appearance to your products. Brilliant metallic finishes can be applied in a wide range of colors at surprisingly low cost.

Today's vacuum coatings are brighter than buffed and polished electroplating, cost less, and in some applications, stand up better.

Send us a sample of your product and give us details about its use. We'll tell you whether your application is a good one, show you how your product will look, and estimate your operating costs. We can supply a complete installation, guarantee its output, and train your operators. Write us today!

A wide variety of products and materials can be coated economically with unmatched beauty.



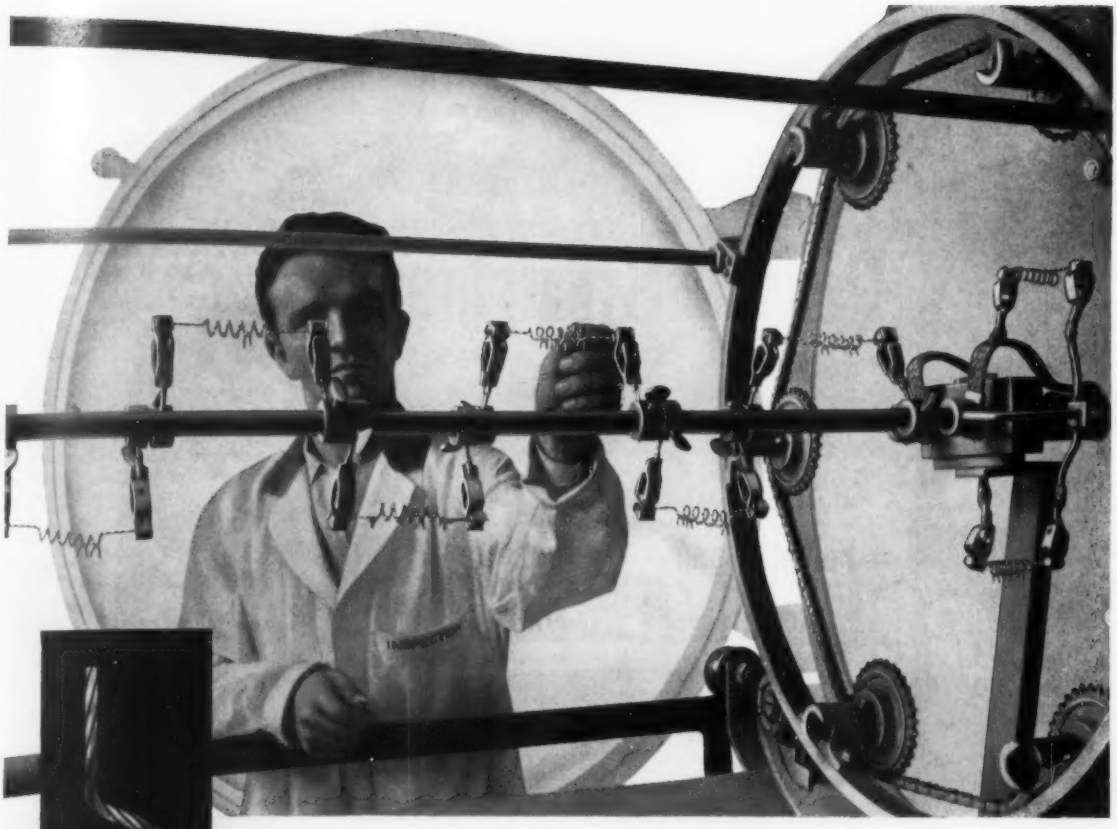
High Quality, easy loading, and short cycle time are possible through advanced high vacuum engineering.

NRC

NRC EQUIPMENT CORPORATION

A Subsidiary of National Research Corporation

DEPT. 197, CHARLEMONT ST., NEWTON 61, MASS.





Looking for more "shots per dollar" in vacuum metallizing coils?

By switching to the best coil design, vacuum metallizers have realized as much as 30% more shots per dollar from Sylvania Tungsten Coils. Why is this possible? Because Sylvania helps vacuum metallizers find the right coil to do their job most economically. Whether you buy ready-made coils or form your own from tungsten strand, Sylvania is ready to help you get maximum efficiency.

If your metallizing process calls for a custom-made coil, Sylvania can recommend the best design consistent with the equipment you're using and the metallizing job to be done. In many cases, metallizers can get top efficiency from an existing Sylvania design, many of which have already become so popular they are considered standard.

Sylvania coils are formed of high-density tungsten strand manufactured to exacting standards of quality control. Sylvania Tungsten Strand is available in 3 to 7 ply with wire diameters of 0.020 to 0.600 inches per strand.

We invite you to write, outlining your specific requirements and problems. You'll find Sylvania is your best source for vacuum metallizing coils designed and built to offer "more shots per dollar."

Sylvania Electric Products Inc.
Tungsten and Chemical Division, Towanda, Pa.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

SYLVANIA

Lighting • Radio • Electronics • Television • Atomic Energy



PLASTIC STAMPINGS

WASHERS • SPECIALTIES • GASKETS

Phenolics	Vinylite
Nylon	Fibre
Polyethylene	High Impact
Acetate	Polystyrene

PLASTIC STAMPING & MOLDING CORP.

2216 W. Armitage Ave. • Chicago 47, Illinois

ARMITAGE 6-9588

Coatings for Plastics

Plastic coatings, specifically formulated, meet rigid performance specifications of automotive, photographic and major appliance industries. Easy application, economical production, non-crazing, excellent terminal durability are proven factors of SULLIVAN plastics coatings.

ACETAPLEX
FOR CELLULOSE ACETATE

BUTAPLEX
FOR CELLULOSE ACETATE BUTYRATE

METALPLEX
FOR VACUUM METALLIZING

PHENOBOND
FOR PHENOLICS

PLASTAPLEX
FOR POLYSTYRENE

POLYPLEX
FOR ACRYLICS

VINAPLEX
FOR VINYLS

MONOTEX
A TEXTURED FINISH

AUTOMOTIVE ESCUTCHEONS PROJECTOR CASES HOBBY HORSES TELEVISION BEZELS



FOR FURTHER INFORMATION AND TECHNICAL DATA: WRITE

SULLIVAN CHEMICALS

DIVISION OF SULLIVAN VARNISH COMPANY

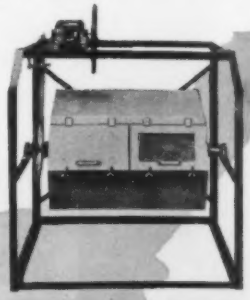
420 NORTH HART STREET · CHICAGO 22, ILLINOIS

Your Key to

BETTER FINISHING

Only **KRAMER's** Tumblers and Buffers give you SUCCESSFUL PRECISION FINISHING with high savings.

Yes! Kramer's Noiseless, chain-driven Tumblers CUTS DOWN YOUR LABOR COST . . . DEBURRS, DEFLASHES, POLISHES to give you the "PERFECT FINISH LOOK" desired to meet your highest standards.



SINGLE BARREL TUMBLER

Size: 30" x 36" or engineered to your specifications. Barrels lined with kiln-dried and glued maple. Child's play to operate. Economical on space as motors are individually mounted overhead—double decked or single. Tumbling supplies available also.



BUFFING LATHE

1 to 7½ H.P. Ball Bearing V-Belt Drive. Pre-determined speed set at factory or to your specifications. Buffing wheels and compounds available for every industry . . . Special compounds recommended for Special applications.

Write Dept. MP for Detailed Information

H. W. KRAMER CO.

120-30 JAMAICA AVENUE

RICHMOND HILL 18, N. Y.

get AHEAD STAY

in Your Spray Decorating with Conforming Matrix



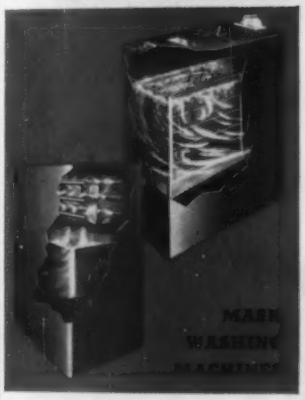
AUTOMATIC MACHINES

Manufacturers of all the equipment needed to equip you with the most practical system for handling your particular projects most efficiently.

A trained engineering staff familiar with all types of materials, translucents, teflon and metallics, and with knowledge of die casting, stamping and plastic molding procedures as they relate to high production spray finishing.

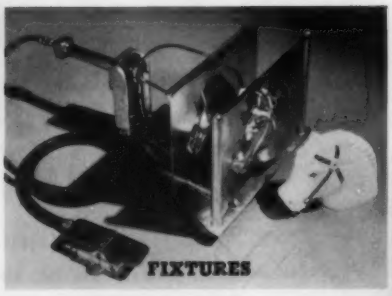
AUTOMATIC MACHINES—Standard and special automatic and semi-automatic machines for decorating parts of all sizes and shapes. High production with small investment. Skilled operators unnecessary. Automatic clamping and ejection of parts. Adjustable sequence-type operation. Hydraulic two-fluid control system maintains accurate repeats and eliminates cost of explosion-proof controls. Paint in one or two directions. Steady, hydraulic controlled gun movement.

MASK WASHING MACHINES—The fastest, really efficient, explosion-proof automatic mask washers. Increase production with fewer tools. Eliminate damage and costly repairs of masks. Lowest solvent consumption. High pressure, no-leak pump.



FIXTURES—Mechanical and air operated clamps and pressure fixtures for holding masks and parts. Special and standard fixtures speed up production, assure highest quality work. Horizontal: adjustable to masks 3" to 36". Vertical: revolve 360°. Square shaft registering air piston. Ejectors prevent distorted parts or parts from different cavities from sticking in mask. Double Acting: apply pressure to both sides of parts to be painted on two or more sides with one masking.

MASKS—Electro-formed nickel or copper masks of all types for shielding and spraying highly intricate areas in single or multiple colors. Permit more shots between washings. Allow for reasonable dimensional differences in piece parts. Finger clearance affords easier loading of parts. Right hand tab masks free both hands for productive movements.



FIXTURES

Send prints or sample parts, giving production requirements and results you wish to achieve.



MASKS

C M

Conforming Matrix
CORPORATION

364 Toledo Factories Building — Toledo 2, Ohio

NOW YOU CAN

HEAT SEAL

MOLDED PLASTIC* PARTS

* POLYETHYLENE and OTHER THERMOPLASTIC PARTS

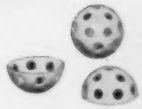


The Cosomatic Sealer automatically and without the use of adhesives, seals polyethylene parts on a production basis. This is the first commercially practical machine available for heat sealing molded polyethylene parts. It has been released after eleven years of development and nine years of actual use in product manufacture. Both the process and machine are covered by United States and foreign patents. WRITE TODAY FOR COMPLETE INFORMATION.

COSOMATIC SEALER

- Completely automatic sealing cycle.
- Accommodates a wide variety of shapes and sizes of hollow molded parts.
- Opens a new field of applications for polyethylene.
- Ideal for sealing toys, sporting goods, domestic and chemical containers, housewares and special industrial housings.

Two examples of products sealed using Cosomatic Sealer . . .

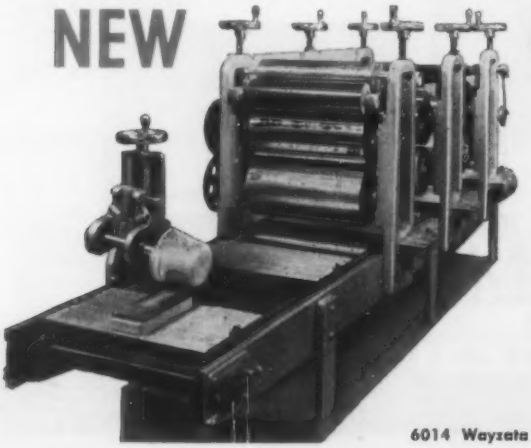


PGB Golf Ball—over 9 million have been sold. (Sealed ball and 2 halves shown.)



Bowlite Bowling Pin Note Intricate Shape.

NEW COSOMATIC PRESS



Prints plastic items faster—better—at lower cost!

- Eliminates decals, hot stamping and slow, expensive silk screening.

Print plastic items never before possible. The Cosomatic Press prints either letterpress or offset—on *three* different levels—up to *three* different colors simultaneously! Flat, round, tapered raised, or recessed faces can be printed in production or short runs, quickly, economically. Used by leading plastic product makers throughout the United States.

FOR COMPLETE INFORMATION ABOUT BOTH COSOMATIC SEALER AND PRESS WRITE:

COSOM ENGINEERING CORP.

6014 Wayzata Blvd., Minneapolis 16, Minnesota Telephone: Liberty 5-8888

TUMB-L-MATIC

is the
SCIENTIFIC COMBINATION of

EQUIPMENT
COMPOUNDS
SUPPLIES
and TECHNIQUES
For *automatically*
Finishing Plastics



BETTER—FASTER—AT LESS COST

Newest *Tumb-L-Matic* development—*a no-wax super finishing compound!* This process brings up the high lustre of the plastic itself . . . eliminates film deposit . . . withstands many washings . . . reduces final clean-up. It's part of a complete line of automatic processes that will finish your parts *faster, at lower* costs than you'd believe possible!

PROVE IT—*Without Cost To You*

Send us a sample of your product. Our engineers will analyze it, recommend the specific process best suited for it, and give you complete production data —FREE. Information on *Tumb-L-Matic's* complete line of equipment, compounds and supplies upon request.

TUMB-L-MATIC, Inc.

ST. MARY'S STREET • STAMFORD, CONN.

When it comes to Marking Plastics



it's PEERLESS for Quality and Economy

- **MANUFACTURE . . . *when roll leaf is part of your product.*** Dials, Gauges, Rulers, etc. must be marked clearly and permanently. The Peerless Process of Roll Leaf Marking provides an easy, economical method.
- **IDENTIFICATION . . . *speed up assembly operation . . . avoid mistakes.*** Small or large plastic parts and products, wiring, perforated panels, numbered and lettered diagrams, etc. lend themselves to Peerless Roll Leaf Marking.
- **LABELLING . . . *lifetime protection for your trade name.*** A Peerless Roll Leaf "label" does not wear or rub off easily because it is engraved into the surface of the material, forming a permanent, integral part of the product.
- **DECORATION . . . *add distinction and buy-appeal to your product.*** Monochrome or multicolor designs may be faithfully and permanently reproduced by the Peerless Process of Roll Leaf Marking. Submit your problem to us.

The Peerless Process of Roll Leaf Marking produces engraved and embossed results at printing speeds, in a wide range of colors including gold and silver. Peerless manufactures its own marking machinery to meet your plant requirements. Write for a free useful sample of Peerless Roll Leaf Marking and a copy of Peerless Folder PL54.

PEERLESS ROLL LEAF COMPANY, INC.

4511-4513 New York Ave., • Union City, N. J.

BRANCH OFFICES:
BOSTON • CHICAGO • *Peerless Roll Leaf Division* • GANE BROS. & LANE, INC.
REPRESENTATIVES:
ST. LOUIS • LOS ANGELES • SAN FRANCISCO • LOUISVILLE • MONTREAL • LONDON, ENG.

HOPP

Pioneer in Plastics

SUPPLIES YOUR EVERY NEED...

with more than 64 years of experience. Known as the leader in this field . . . Hopp has developed unique methods of plastic printing. Hopp has kept pace with industries demands . . . and is able to offer, under one roof, facilities that meet your needs, help solve your problems, and above all . . . save you valuable time and money. Among the diversified facilities are:

★ **PLASTIC PRINTING:** Simple though it sounds, printing on plastics requires years of tireless experimentation to perfect. Special inks and methods, universally used today, were developed, we are proud to say, in our own plant.

★ **PLASTIC LAMINATING:** Using the heat and pressure method of hydraulic pressure lamination exclusively the printed surface is under a protective layer of transparent plastic.

★ **PLASTIC FABRICATING:** Our Fabricating departments are equipped to fabricate printed or unprinted plastic sheetings and perform such operations as die-cutting, bending, numbering, punching, forming, embossing, stamping, shearing, sawing, drilling, cementing, etc.

★ **INJECTION MOLDING:** Making our own dies and molds in our own completely equipped tool rooms.

★ **METAL FABRICATING:** Combining with plastic, makes Hopp an ideal source of supply. Hopp's equipment includes metal rolling, punching, framing, baking, etc.

WHATEVER YOUR REQUIREMENTS IN PLASTICS . . . CONSULT HOPP . . . PIONEER IN PLASTICS SINCE 1893



ABOVE: A FEW OF THE MANY COMPANIES HOPP SERVES WITH CUSTOM-MADE PLASTIC ITEMS

NOW IN OUR 65TH YEAR

PIONEERS IN PLASTICS

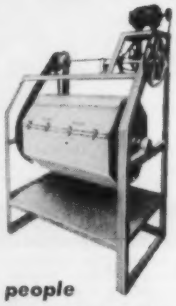
HOPP PLASTICS ©

A DIVISION OF THE HOPP PRESS, INC.

461 WEST 34TH STREET, NEW YORK 1, N. Y.

LUPOLINE

1st in Tumbling Machines
1st in Tumbling Compounds
1st in Know-How

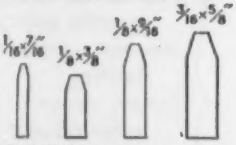


Model 30 H 1 Single Tumbler

See the people who have the know-how!

Let LUPOLINE'S more than 40 years of experience with tumbling equipment, compounds and techniques for finishing plastics go to work for you. Let LUPOLINE'S research and engineering department analyze your product at no cost to you and devise the best finishing process to solve your production problem.

HARDWOOD DOUBLE SCREENED PEGS



LUPOLINE pegs are made of selected hardwood and are double screened to size.

For comprehensive literature on our complete line write to:

LUPOLINE
FIRST IN TUMBLING
COMPOUNDS • EQUIPMENT

LUPOLINE
AUTOMATIC POLISHING EQUIPMENT CORPORATION
99-111 Columbus Avenue
Tuckahoe, N.Y.
Pioneers in the Tumbling Field Since 1911



ATTENTION

PLASTIC MANUFACTURERS-Get Set for Sales

ADD UP TO 50% TO YOUR PROFITS

With Sterling Silver Filigrees

SALES-APPEALING • DISTINCTIVE • LUXURIOUS

- For every plastics application: Lighters, Pen and Pencils, Women's Hi-Fashion Heels, Lipstick and Cosmetic Cases, Men's Jewelry, Cutlery Items — 1001 uses.
- Not sprayed — not painted . . . all metallic effects are electrolytically deposited on the plastic base.
- Actual precious metal is used exclusively with delicate wrought metal overlays — available in 14K gold or gleaming nickel finish.
- Any emblem, insignia, motif, trademark, etc. faithfully reproduced in overall design. Expert staff of skilled craftsmen — designers to work out **your** specific requirements.
- Guaranteed not to chip or rub off under normal use.

FREE OFFER: **Make a luxury item out of an ordinary one!** Send us your samples . . . we'll decorate them and quote prices at NO CHARGE TO YOU!

Exclusive Patented Process

GMC PROCESS CORPORATION
718 BROADWAY, N. Y. 3, N. Y. • GRamercy 5-2313
No connection with General Motors Corp.

Lucite
Plexiglas
Acrylic
Acetate
Butyrate
Cast Phenolic
Epoxy Resin
Ethyl Cellulose
Kel-F
Laminated Bakelite
Nylon
Polyethylene
Styrene Copolymers
Teflon

NOW!

ACE

helps you get FABRICATED PLASTIC PARTS faster... at lowered costs

Balls
Bobbins
Bushings
Collars
Detents
Finials
Grommets
Handles
Knobs
Mechanical Chocks
Name Plates
Pins
Plates
Plugs
Rings
Spacers
Spools
Stands
Strips

Sizes: ⅛" to 2-¼"
Lengths: 1/16" to 9"

New e-x-p-a-n-d-e-d production facilities now give you ACE HIGH QUALITY on all types of *screw machine, centerless ground parts* and *special shapes . . . all colors . . . all materials.*

Write, wire, phone for samples, prices and bulletin listing stock items. Send specifications or blueprints for prompt quotations on specials.

Ace PLASTIC COMPANY
Extrusion Molders and Fabricators
91-62 Van Wyck Expressway, Jamaica 35, N.Y. JAmaica 3-5500

FOIL LEAF MARKING DIES *and* SPRAY MASKS



- Precisely engraved dies with controlled face and bevels for perfect marking. Any design detail or lettering style you desire.
- Conforming masks for color-spray finishing. Every contour formed exactly. Snug fit assured . . . easy to use.

Write for information on your product marking. Send samples or drawings.

JAS. H. MATTHEWS & CO.

3951 Forbes St. Pittsburgh 13, Pa.

OFFICES IN PRINCIPAL CITIES

HOT STAMP ON PLASTICS?

Investigate the Advantages of

GENERAL ROLL LEAF

General makes a complete line of roll leaf for hot stamping on every type of plastic. General Roll Leaf provides superior workability, finer definition and longer life. Available in the widest assortment of colors as well as genuine gold and imitation gold and silver.

Free Samples and Illustrated Literature Available on Request

IMMEDIATE DELIVERY and service from warehouses in principal cities coast-to-coast.



GENERAL ROLL LEAF MANUFACTURING CO.

Genuine and Imitation Gold and Silver, Pigment and Metallic Colors

85-03 57th Ave. Elmhurst, L. I., N. Y. HAvermeyer 9-6123

BOSTON • CHICAGO • LOS ANGELES

Industry-wide recognition for LOGO Coatings and Finishes

Custom molders . . . manufacturers . . . sign companies . . . materials suppliers* — all recognize LOGO as a top single-source for economical, easy to handle . . . . . .

*LOGO paints—approved by the Rohm & Haas Company for Plexiglas.

—recommended by Eastman Chemical Products, Inc. for Tenite Butyrate and Tenite Acetate.
—listed by the Dow Chemical Company for Styron.

Outdoor paints
Pigmented and metallic paints
Vacuum metallizing finishes
Spray, screen, letter-fill and roller coatings
Destaticizing agents
Strip coatings

Local warehouses insure prompt delivery.

LOGO offers a series of informative technical bulletins on coating, screening, destaticizing plastics. Write for free copies today!

LOGO, INC.

DIVISION BEE CHEMICAL COMPANY

12901 South Stony Island Ave., Chicago 33, Illinois

Mitchell 6-0400

New York: Worth 4-6650

CHECK THREE WAYS *to get more value out of advertising to packagers!*

✓ 1 CHECK THE CIRCULATION of packaging magazines: MODERN PACKAGING has the largest paid circulation in the field . . . and what's more, packagers are willing to pay a big $7 a year for it, at that!

Why is paid circulation so important?

Because of the intricate purchasing patterns involved in the selection and specification of containers, packaging materials and equipment, it's not possible to select "packaging men" simply on the basis of job titles.

For this reason, MODERN PACKAGING's policy of *paid circulation* is vitally important to advertisers. It is insurance that the magazine's readers are directly and intimately concerned with packaging operations: they've *vouched for themselves and their interests* by laying hard cash on the line. Most significantly, this paid circulation keeps climbing to match the rapid growth of the field year after year . . . climbing 40% in the past five years!

As the one magazine in the field with paid, ABC-audited circulation – and a high renewal rate of 72% – MODERN PACKAGING gives advertisers assurance of interested readers . . . interested in *packaging!*

✓ 2 CHECK THE EDITORIAL EFFECTIVENESS of packaging magazines: Since 1952, seven independent surveys* show that MODERN PACKAGING is *read* and *preferred* by more men-who-specify-and-buy-for-packaging than any other magazine in the field!

And the reason is plain:

The editorial purpose of MODERN PACKAGING is to keep packagers informed of all the significant advances in packaging methods, materials and equipment. Editorial feature space is devoted to carefully researched original articles. About 90% is staff written, 10% contributed by authorities in the field. Through the use of analyses, illustrations, case histories and "how-to-do-it" articles, the editors point out and interpret packaging trends.

The Technical Section, dealing with physical and chemical problems and developments in the field, is considered as the Number One reference text of packaging engineers and technicians.

New design developments in packaging and packaging display are regularly covered by the pictorial features: "Packaging Pageant," "Design History" and "Display Gallery."

Other closely read editorial departments are: "Equipment and Materials," "Plants and People," and "U. S. Patents Digest."

In short, MODERN PACKAGING is *read* and *preferred* for its authoritative editorial coverage of new materials and equipment, packaging trends, and for its comprehensive technical data on materials and production!

✓ 3 CHECK THE ACCEPTANCE BY ADVERTISERS of packaging magazines: Year after year, more advertisers invest more money in more space in MODERN PACKAGING than in *all other packaging publications combined.* And last year they spent more dollars for more space in MODERN PACKAGING than ever before! Most of them *keep* using its pages year after year–almost 60% are 5-to-25-year-old advertisers in MODERN PACKAGING!

Who are these advertisers? They are manufacturers of packaging *materials and supplies*, including:

Adhesives, coatings, cork, fabric, film, foil, glass, ink, wood, paper, plastics, rubber, tape and wax.

And MODERN PACKAGING advertisers also include makers of *containers*, such as:

Bags, bottles, boxes, cans, cartons, chests, crates, capsules, drums, envelopes, jars, tubes, vials and wrappers.

Other MODERN PACKAGING advertisers sell such *machinery and equipment* as:

Bag machines, bottling equipment, box machines, capping equipment, cartoners, conveyors, counters, die-cutters, filling machines, labelers, printing presses, scales, slitters, staplers, stitchers, unscramblers and vibrators.

And included among MODERN PACKAGING advertisers are companies offering such *services* as:

Designing, embossing, fabricating, laminating, plastic molding, and contract packaging.

**Write for the full reports of all 7 surveys. For further information on the market and the magazine, ask for the 44-page data book, "The Packaging Field . . . and How to Reach It," and for the booklets, "Let's Take the Measure," and "Basic Editorial Policies."*

MODERN PACKAGING ENCYCLOPEDIA ISSUE



Published annually in November, it's the standard workbook of the nation's packaging men . . . a complete encyclopedia of packaging materials, equipment and methodology. Last year's issue ran to 834 pages . . . covered all phases of packaging design and production. Closing date: August 2nd.



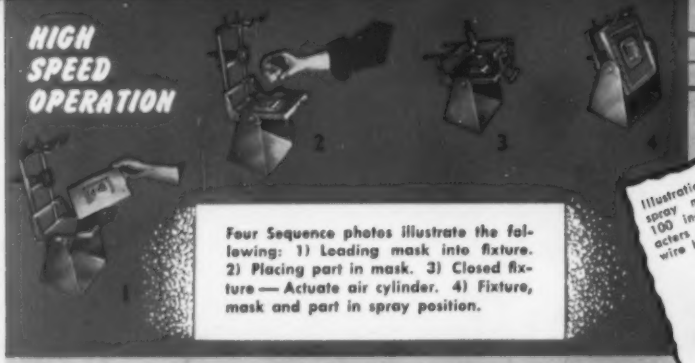
ABP/ABC

MODERN PACKAGING

A BRESKIN PUBLICATION

575 Madison Avenue, New York 22, N. Y.

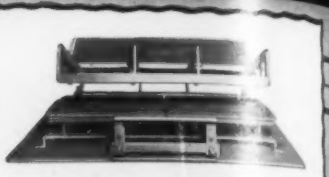
HIGH SPEED OPERATION



Four Sequence photos illustrate the following: 1) Loading mask into fixture. 2) Placing part in mask. 3) Closed fixture — Actuate air cylinder. 4) Fixture, mask and part in spray position.

Illustration shows a very delicate spray mask incorporating over 100 individual suspended characters on .040 diameter music wire bridges.





Two-tone air conditioning grille — mask and fixture adaptable to various size grilles.



Mask and part illustrating one of many typical applications for masking.

YOUR spray mask finishing problem from blue print to complete production tooling — We serve in the following capacity: CONSULTANTS for proper parts design to achieve lower cost and peak efficiency in your finishing department. ENGINEERS for the most modern methods of production spray mask painting techniques. DESIGNERS of spray masks, jigs, and fixtures, mechanical and air-operated. MANUFACTURERS of nickel electro-formed spray masks, jigs, and fixtures.

Thierica Studio

Spray Mask Finishing

• DESIGNERS — ENGINEERS — MANUFACTURERS •

902 Clancy Ave., Grand Rapids, Michigan

"Thierica" for

ELECTRO-NICKEL SPRAY MASKS FIXTURES AND JIGS •

ASSOCIATED IN THE INTEREST OF



MOST MODERN FACILITIES

FINE QUALITY FINISHING

Associated under the same roof to provide a complete and coordinated advisory and manufacturing service for your finishing problems from the blue print stage through planning, manufacturing and tooling.

We welcome every opportunity to work with you in an advisory capacity. There is no obligation.

AUTOMATIC SPRAY MASK FINISHING SYSTEMS *by* **Sepanski and Associates**

902 Clancy Ave., Grand Rapids, Michigan

"Sepanski" for

AUTOMATIC SPRAY MASK FINISHING SYSTEMS and SPRAY MASK WASHERS

A COMPLETE line of automatic equipment for your finishing requirements — Automatic Spray Mask Painting Equipment — Automatic Spray Mask Washing Equipment. Air operated for greater efficiency and flexibility of arrangement in your finishing department. Submit your print or part for production estimate at no charge or obligation.

STANDARD MODELS

AUTOMATIC SPRAY-MASK WASHING UNITS



MODEL W-54-H



MODEL W-54-M



MODEL W-54-V



MODEL 1800

STANDARD AUTOMATIC SPRAY-MASK PAINTING MACHINE

MODEL	STROKE
1200	12"
1800	18"
2400	24"

Custom Automatics

Designed and Built for Special Mask Finishing Applications





STANDARD MODEL 5-M

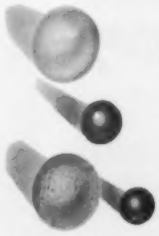
Complete versatility for almost any small parts.

Available in 6 spray-gun combinations (stationary and up to 4 oscillating guns).

Other features available for special applications.

BALLS UNLIMITED

FOR UNLIMITED APPLICATIONS



We specialize in the manufacture of precision balls in desired diameters made from non-metallic materials including.

ACETATE BUTYRATE POLYSTYRENE
NYLON TEFLON LUCITE EPOXY
STYROFOAM WOOD CORK FIBER

Remember, only a *ball* does the *job of a ball.*

So consider a ball for your purpose—and consider the job well done by ORANGE PRODUCTS.

Small turnings of cylindrical shapes formed from round rods and tubes for all types of applications.

Range of sizes is from ⅛" to 1" diameter and up to 7" long. We hold tolerances of .002 on plastic and .005 on wood, plus or minus.

ORANGE PRODUCTS, INC.

554 MITCHELL ST., ORANGE, NEW JERSEY

PLASTIC MARKING

Stamp Names, Trademarks, etc. right in your own shop with the *High-Precision Kingsley Machine*

Simple, easy to use. No skilled operators necessary.

Write us about your marking requirements. Send a sample or dimensions of parts to be stamped. We'll reply air mail with complete details on how a Kingsley Machine can be applied to your specific problem.

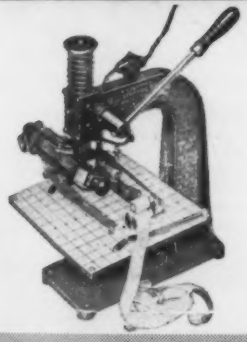


UP TO 1000 STAMPINGS PER HOUR

Uniform, high-quality impressions that add appearance value to your product.

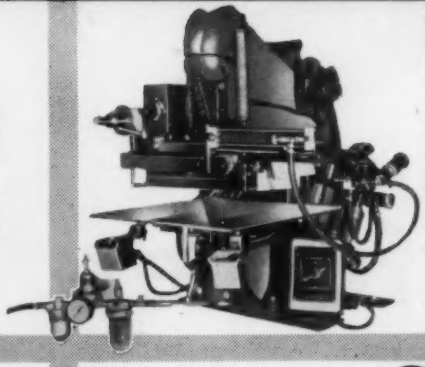
KINGSLEY
STAMPING MACHINE CO.
HOLLYWOOD 38, CALIFORNIA

HOT STAMPING PRESSES *in a* COMPLETE RANGE



The BUILDER MODEL KWIKPRINT

is one of 4 hand operated models of which there are thousands in daily use on small as well as production runs. Has an automatic roll leaf attachment and tiltable typeholder for quick changes of type or dies.

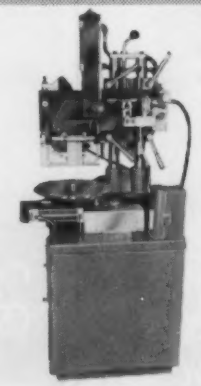


KENSOL 50 ROLL LEAF STAMPING PRESS

This is the latest type extra heavy duty high speed, double toggle press, air operated with electric dwell timer, thermostat, with 9 x 12" head and automatic roll leaf attachment. Head size 6 x 9 and larger than 9 x 12 equipped with criss cross roll leaf attachment also available. This is only one of several Kensol models in hand or air operated machines.

PEERLESS MODEL G HEAVY DUTY TOGGLE ACTION AIR OPERATED STAMPING PRESS

Illustration shows dial table, but can also be had with slide table, both air operated and synchronized with head. Has deep throat, adjustable head up to 6" maximum day light, with assorted head and chase sizes, bulky 2¼" posts, deep set in base casting for rigid support, air operated roll feed attachment, etc. Only one of several Peerless models for hand and air operation.



Plus

a complete line of roll feed attachments — hot plates — stamping foils in ALL colors — rubber dies — die mount — jigs and fixtures — brass and steel type — etc.

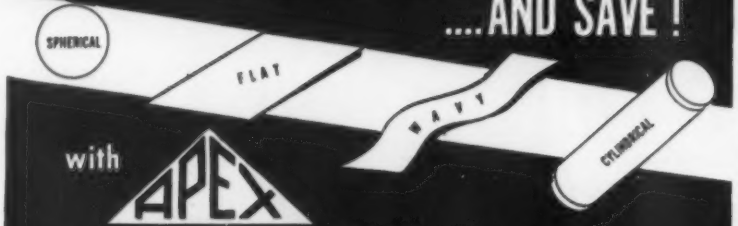


WRITE FOR PARTICULARS

For additional information, see ads of Olsenmark Corp. and Peerless Roll Leaf Co.

GANE BROTHERS AND LANE, INC.
1335-45 W. LAKE ST., CHICAGO 7, ILL.
ST. LOUIS • NEW YORK • SAN FRANCISCO • LOS ANGELES • BOSTON

Decorate or Print
DIRECTLY ON YOUR PRODUCT ....AND SAVE !



with APEX
Decorating & Marking Equipment

- 1, 2 or more colors in perfect register
- automatic or hand feed machines.
- rapid changeover
- inexpensive plates
- permanent inks in all colors.

OVER 40 STANDARD MODELS TO CHOOSE FROM in America's Largest and Most Complete Selection

There's an Apex machine that can mark, label or decorate directly on your product, no matter the size or shape. Anything that can be printed on paper can be printed by an Apex. No item is too large or small . . . no run too long or too short. Apex eliminates label inventory problems, gives you unmatched versatility and relief from production headaches. Get all the facts today.

Ask for literature on the new, high speed, instantaneous drying Apex aniline multicolor lid and cylindrical container printing equipment.
COMPLETE MARKING SUPPLIES: Inks, Type for Printing or Stamping Foils.

APEX MACHINE COMPANY
14-13 118th STREET COLLEGE POINT 56, N. Y.
Largest and Oldest Mfr. of Multicolor Ink Printing and Hot Stamping Machines.



You can decorate them

faster

and better. Today's production speeds are so far ahead of 1953-1954 that plants with out-dated decorating methods **can't compete at a profit.**

Many Fin-E-Co machines are now painting up to 1,200 parts an hour—wiping as many as 1,000 parts an hour—other operations at same 1957 pace.

Is your decorating competitive? Won't cost you anything to find out; just send us samples of parts you decorate. FINISH ENGINEERING CO., INC., 1115 Cherry St., Erie, Pa. Phone 5-4478.

Makers of Masks and Vacuum Plating Racks, Mask Washers, Painting and Wiping Machines, Painting Fixtures, Stainless Steel Screens and Fixtures for Silk Screen Process, Roller Coaters.

FINISH ENGINEERING CO., INC.

plastic film and plastic sheeting

electronically welded
(HEAT SEALED)

for Industrial uses

- Complete Fabricating Facilities
- Skilled Designing Departments
- Highly Competent Engineering Techniques

Three good reasons why "Fabrico" industrial plastic engineers are way ahead in the research, design and fabrication of electronically welded plastic film and sheeting for industrial applications.

inflatables:
for industrial uses, advertising and display purposes, etc.

protective covers:
for machine tools, appliances and similar items.

We Invite Your Inquiries

Fabrico manufacturing Corp.
1716 W. Division • Chicago, Ill.

DIALS • INSIGNIAS • PANELS

anything in plastics can be finished better with Anchor Specialized Dial Coatings

Our specialization in Dial Finishes over many years has earned a reputation for quality in products and results.

These two products are cutting finishing time and costs for leading plastics fabricators.

Anchor Plastic Lacquers are extensively used both as a back up paint and an overall finish on dials. Rapid drying, excellent build and hiding, perfect adhesion and color retention. Made to fit the specific requirements of the plastic for which it is used.

Anchor Dial Filler dry-wipes in minutes. Won't streak, produces a clean, sharp opaque color with a minimum of time and labor. May be applied by brush, roller, squeezer or spray. In colors to meet your color standards.

These two specialized products are being used by many of the nation's largest manufacturers. You can use them with confidence.

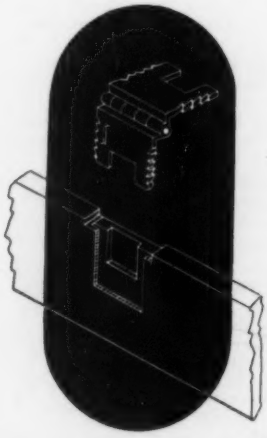
THE IRVIN, JEWELL & VINSON CO.
115 E. Third Street, Dayton 2, Ohio

FREE TRIAL OFFER
Try a sample of Anchor Dial Filler or Plastic Lacquer. Check the advantages yourself. Or write for descriptive literature.

HINGES . . .

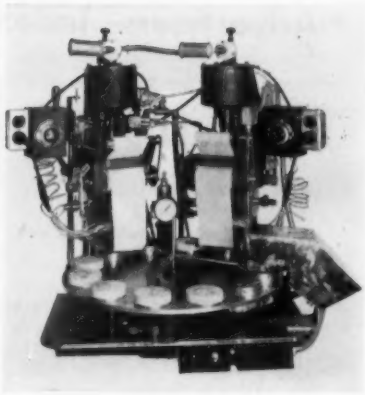
for PLASTIC BOXES

press-fit assembly
(Holds like
a drive-screw)
with
or without
double action
"C" Springs



GEISSEL *Mfg. Co., Inc.*

109 LONG AVENUE, HILLSIDE, N. J., U. S. A.



marking and imprinting machine

- **for sheeting, rods and bar stocks**
- **for belting, tubing and coat wire**
- **for molded products- all types in all shapes**

Ackerman-Gould machines are known for the quality results they deliver in marking and decorating on all types of plastic materials. We specialize in the manufacture of small hot press marking machines with automatic work feeds, increasing production to the maximum. If you have the production, we have the know-how on automatic dial, hopper, or magazine feeding, methods, also dies, fixtures and proper marking roll leaf.

Our extensive experience with marking and decorating wire and plastics is available to you . . . bring us your problems for solution.

ackerman-gould company

92 Bleecker Street, New York, N. Y.
PRECISION MACHINES For:
marking • embossing • printing • decorating

Advertisers' Index

MACHINERY AND EQUIPMENT

(Listings do not necessarily cover entire lines of advertisers nor all producers in each category.)

EDITORIAL TEXT FOR THIS SECTION BEGINS ON PAGE 980.

ACCESSORIES FOR EXTRUSION MACHINES
Faeco Machine Co., Inc. 952
Hartig Engine & Machine Co. 948
National Rubber Machinery Co. 869-872
Negri Bossi & Company 966
Progressive Machine Co., Inc 983
Reifenhauser, A. 987
Reliance Electric & Engineering Co. 944
Robbins Plastic Machinery Corp. 968, 969

ACCESSORIES FOR INJECTION MOLDING PRESSES
Injection Molders Supply Co. 867

ACCESSORIES FOR PLASTISOL MOLDING
Mercury Industries Inc., Vinyl Plastics Equipment Div. 964

ACCUMULATORS
Dunning & Boschert Press Co., Inc. 949
Elmes Engineering Division, American Steel Foundries 938, 939
Johnson Machinery Co. 954
Wood, R. D. Company 918, 919

ARBOR PRESSES
Dake Corporation 876

AUTOCLAVES
Adamson United Company ... 930, 931

BLENDERS
Abbe, Paul O., Inc. 912
Bailey, R. N., & Co., Inc. 925
Entoleter Division, Safety Industries, Inc. 954

BRAKE & TIRE TESTERS
Adamson United Company ... 930, 931

CALENDERS
Adamson United Company ... 930, 931
Bolling, Stewart, & Company, Inc. 868
Johnson Machinery Company 954

COATERS
Hofmann & Schwabe 882
Industrial Ovens, Inc. 962
Liberty Machine Co., Inc. 917
Litzler, C. A., Co., Inc. 921
Waldron, John, Corporation .. 942, 943

COMPRESSION MOLDING PRESSES
Automatic Molding Machine Co. 883
B. I. P. Engineering Ltd. 960
Becker & Van Hullen 963
Bolling, Stewart, & Company, Inc. 868
Clifton Hydraulic Press Co. 928
Dake Corporation 876
Davidson-Kennedy Company 982
Dunning & Boschert Press Co., Inc. 949
Elmes Engineering Division, American Steel Foundries 938, 939
Erie Foundry Co. 886
French Oil Mill Machinery Co., The, Hydraulic Press Div. 985
Hull-Standard Corporation 955
Hydraulic Press Mfg. Co., The 878, 879
Improved Machinery Inc. 1013
Johnson Machinery Co. 954
Lake Erie Machinery Corp. 999
Lawton, C. A., Company, The ... 1006
Lodge & Shipley Co., The 1008
M & N Modern Hydraulic Press Co., Inc. 1002
Stokes, F. J., Corporation 889
Triulzi, A. 940, 941
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951
Williams-White & Co. 1000

CONTROLLERS & CONTROLS
Barber-Colman Company 984
Curtiss-Wright Corporation, Electronics Div. 998
Electric Auto-Lite Company, The, Instrument and Gauge Div. ... 949
Improved Machinery Inc. 1013
Industrial Mfg. Corp. 932
Powers Regulator Co., The 920
Reliance Electric & Engineering Co. 944
Sterling, Inc. 873
Taylor-Emmett Controls, Inc. . 956, 957
Thermo Electric Co., Inc. 982
Vickers Incorporated, Div. Sperry Rand Corp. 1009-1012
West Instrument Corporation 927

COOLING TRAINS
Black-Clawson Company, The, Dilts Div. 981

CURERS FOR FLAT ARTICLES
Adamson United Company ... 930, 931

CYLINDERS
Cylinder Mfg. Co. 978
Lawton, C. A., Company, The 1006
Miller Fluid Power, Div. Flick-Reedy Corp. 994

DIES
Akron Presform Mold Co., The .. 929
Liberty Cutting Die Company ... 948
Robbins Plastic Machinery Corp. 968, 969

DIE CUTTING MACHINES
Falls Engineering and Machine Co., The 972

DRILL PRESSES
Mico Instrument Company 995

DRUM TUMBLERS
Injection Molders Supply Co. . 867, 961

DUMPERS
Bailey, R. N., & Co., Inc. 925

DUPLICATING MACHINES
Gorton, George, Machine Co. 1016

ELECTRONIC HEAT SEALERS
Cosmos Electronic Machine Corp. 991
Erdco Engineering Corporation .. 916
Mayflower Electronic Devices, Inc. 1014
Sealomatic Electronics Corporation 926
Radio Receptor Company, Inc., Thermatron Division 927

EMBOSSING MACHINES
Liberty Machine Co., Inc. 917
Litzler, C.A., Co., Inc. 921

ENGRAVING MACHINES
Mico Instrument Company 995
New Hermes Engraving Machine Corp. 991

EXPANDER FOR FILM & SHEET
Progressive Machine Co., Inc. ... 983

EXTRUDER CYLINDERS
Industrial Research Laboratories, Div. Honolulu Oil Corp. 1015

EXTRUSION LAMINATORS
Black-Clawson Company, The, Dilts Div. 981

EXTRUSION MACHINES
Davis-Standard, Div. Franklin Research Corp. 888
Egan, Frank W., and Company .. 884
Hartig Engine & Machine Co. ... 948
Hale and Kullgren, Inc. 877
Johnson Machinery Co. 954
Killion Tool & Manufacturing Co. . 923
Modern Plastic Machinery Corp. .. 885
National Rubber Machinery Co. 869-872
Negri Bossi & Co. 966
Prodex Corporation 946, 947
Projectile and Engineering Co., Ltd., The 990
Reed-Prentice 976, 977
Reifenhauser, A. 987
Royle, John & Sons 965
Shaw, Francis & Co. Ltd. 979
Stokes, F. J., Corporation 889
Welding Engineers, Inc. 993
Windsor, R. H., Ltd. 934, 935

FABRICATING MACHINES & EQUIPMENT
American Agile Corporation 974
Standard Tool Company 922

FILM TREATING EQUIPMENT
Aetna Electronics Corp. 997

FILTER CONE ATTACHMENT
Whitlock, C. H. Associates 920

FILTERS
Marvel Engineering Company 933

GRANULATORS, GRINDERS, PELLETIZERS
Abbe, Paul O., Inc. 912
Bailey, R. N., & Co., Inc. 925
Brosites Machine Company, Inc. .. 911
Cumberland Engineering Co., Inc. 875
De Mattia Machine and Tool Co. . 988
Hartig Engine & Machine Co. ... 948
Injection Molders Supply Co. . 867, 961
Johnson Machinery Co. 954
Metals Disintegrating Co., Inc., Pulverizing Machinery Div. 986
Ross, Charles & Son Company, Inc. 984
Taylor-Stiles & Co. 975
Van Dorn Iron Works Co., The .. 887

HEATING & COOLING UNITS
Faeco Machine Co., Inc. 952
Fostoria Pressed Steel Corporation 913
Industrial Mfg. Corp. 932
Injection Molders Supply Co. 961
Mayer Refrigerating Engineers, Inc. 1016
Sarco Company, Inc. 971

HEATING ELEMENTS
Glenn Electric Heater Corporation 953
Industrial Mfg. Corp. 932
Industrial Heater Co., Inc. 992
Thermel, Inc. 1005
Watlow Electric Manufacturing Co. 1000
Wiegand, Edwin L., Company 970, 971

HIGH FREQUENCY GENERATORS
Erdco Engineering Corporation .. 916

HOPPER DRYER
Thoreson-McCosh, Inc. 986
Whitlock, C. H., Associates 920

HOPPER LOADERS
Whitlock, C. H. Associates 920

HYDRAULIC PRESSES
Clifton Hydraulic Press Co. 928
Custom Machine & Design, Inc. .. 952
Dake Corporation 876
Davidson-Kennedy Co. 982
Dunning & Boschert Press Co., Inc. 949
Elmes Engineering Division, American Steel Foundries 938, 939
Erie Engine & Mfg. Co. 989
Erie Foundry Co. 886
French Oil Mill Machinery Co., The, Hydraulic Press Div. 985
Johnson Machinery Co. 954
Lake Erie Machinery Corp. 999
Lawton, C. A., Company, The 1006
Lodge & Shipley, Co., The 1008
Logan Hydraulics, Inc. 936
M. & N. Modern Hydraulic Press Co., Inc. 1002
Stokes, F. J., Corporation 889
Triulzi, A. 940, 941
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951
Williams-White & Co. 1000
Wood, R. D., Company 918, 919

HYDRAULIC PUMPS
Dunning & Boschert Press Co., Inc. 949

INJECTION MOLDING MACHINES
Battenfeld 881
Becker & Van Hullen 963
Clifton Hydraulic Press Co. 928
De Mattia Machine and Tool Co. 988
Fellows Gear Shaper Company, The, Plastic Machine Div. 996
Hydraulic Press Mfg. Co., The 878, 879
Improved Machinery Inc. 1013
Johnson Machinery Co. 954
Lester-Phoenix, Inc. 880
Lewis Welding & Engineering Corp., The, Machine Div. 1007
Lombard Governor Corporation .. 958
Moslo Machinery Company 1001
Negri Bossi & Co. 966
Newbury Industries 945
Projectile and Engineering Co., Ltd., The 990
Reed-Prentice 976, 977
Simplomatic Mfg. Co. 922
Standard Tool Company 922
Stokes, F. J., Corporation 889
Triulzi, A. 940, 941
Van Dorn Iron Works Co., The .. 887
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951
Windsor, R. H., Ltd. 934, 935

LABORATORY PRESSES
Carver, Fred S., Inc. 914, 915
Erie Engine & Mfg. Co. 989
Lake Erie Machinery Corp. 999
Simplomatic Mfg. Co. 922
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951

LAMINATING PRESSES & EQUIPMENT
Becker & Van Hullen 963
Carver, Fred S., Inc. 914, 915
Faeco Machine Co., Inc. 952
French Oil Mill Machinery Co., The, Hydraulic Press Div. 985
Hoffman & Schwabe 882
Hydraulic Press Mfg. Co., The 878, 879
Lake Erie Machinery Corp. 999
Litzler, C. A., Co., Inc. 921
M & N Hydraulic Press Co. 1002
Triulzi, A. 940, 941

MACHINE TOOLS
Cincinnati Milling Machine Co. .. 866
Niagara Machine & Tool Works .. 959

MILLING MACHINES
Cincinnati Milling Machine Co. .. 866

MILLS
Abbe, Paul O., Inc. 912
Adamson United Company ... 930, 931
Bolling, Stewart & Company, Inc. 868
Entoleter Division, Safety Industries, Inc. 954
Erie Engine & Mfg. Co. 989
Ross, Charles, & Son Company, Inc. 984
Thropp, Wm. R., & Sons, Div. J. M. Lehmann Co., Inc. 1002

MIXERS
Abbe, Paul O., Inc. 912
Bolling, Stewart, & Company, Inc. 868
Entoleter Division, Safety Industries, Inc. 954
Progressive Machine Co., Inc. 983
Ross, Charles, & Son Company, Inc. 984

MOLDS, BASES, PLATENS, ETC.
Akron Presform Mold Co., The ... 929
Anson Tools & Gauges, Inc. 978
Custom Engineering Co. 978
Van Dorn Iron Works Co., The .. 887
Wood, R. D., Company 918, 919

OVENS & DRYERS
Brenner, I. G., Co. 910
Brosites Machine Company Inc. .. 911
Erie Engine & Mfg. Co. 989
Fostoria Pressed Steel Corporation 913
Glenn Electric Heater Corporation 953
Industrial Ovens, Inc. 962
Lydon Bros., Inc. 1014
Stokes, F. J., Corporation 889
Stromes Systems, Inc. 975

PANTOGRAPHS
Gorton, George, Machine Co. 1016

PREFORMING MACHINES
B. I. P. Engineering Ltd. 960
Brenner, I. G., Co. 910
Erie Engine & Mfg. Co. 989
Logan Hydraulics, Inc. 937
Stokes, F. J., Corporation 889

PREPLASTICIZING UNITS
Improved Machinery Inc. 1013
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951

PRESSES FOR REINFORCED PLASTICS
Dake Corporation 876
Daniels, T. H. & J., Ltd. 974
Elmes Engineering Division, American Steel Foundries 938, 939
Erie Engine & Mfg. Co. 989
Hydraulic Press Mfg. Co., The 878, 879
Triulzi, A. 940, 941

PRINTING PRESSES
Faeco Machine Co., Inc. 952
Hofmann & Schwabe 882
Liberty Machine Co., Inc. 917
Waldron, John, Corporation .. 942, 943

PUNCHES & DIES
Stokes, F. J. Corporation 889

PUMPS
Hardman, H. V. Co., Inc. 948

RADIATION ACCELERATORS
Applied Radiation Corporation .. 973

ROTATIONAL CASTING MACHINES
Akron Presform Mold Co., The .. 929
Mercury Molding Machinery Inc. 964

ROVING CUTTERS
Brenner, I. G., Co. 910
Erie Engine & Mfg. 989

SAW BLADES
Lemmon and Snoap 995

SEPARATORS
Bailey, R. N. & Co., Inc. 925

SHEARS, CUTTERS, & SAWS
Becker & Van Hullen 963
Falls Engineering and Machine Co., The 972
Foster & Allen, Inc. 916
Hobbs Mfg. Co. 992, 1014
Johnson Machinery Co. 954
Lodge & Shipley Co., The 1008
Niagara Machine & Tool Works .. 959
Taylor-Stiles & Co. 975
Robbins Plastic Machinery Corp. 968, 969

SPRAY EQUIPMENT
American Agile Corporation 974
De Vilbiss Company, The 992

SPLICERS
Robbins Plastic Machinery Corp. 968, 969

SLITTERS, SHEETERS & REWINDERS
Doven Machine & Engineering Co. 936
Dusenbery, John, Company 995
Falls Engineering and Machine Co., The 972
Hobbs Mfg. Co. 992, 1014
Robbins Plastic Machinery Corp. 968, 969
Waldron, John, Corporation .. 942, 943

STEAM GENERATOR
Pantex Mfg. Corp. 991

SURFACE PYROMETERS
Cambridge Instrument Company, Inc. 972

SURFACE SIZING MACHINES
Buss Machine Works 981

TAKE-OFF EQUIPMENT
Black-Clawson Company, The Dilts Div. 981
Dusenbery, John, Company 995
Faeco Machine Co., Inc. 952
Hartig Engine & Machine Co. 948
Liberty Machine Co., Inc. 917
National Rubber Machinery Co. 869-872
Progressive Machine Co., Inc. 983
Robbins Plastic Machinery Corp. 968, 969

TAPPERS
Mico Instrument Company 995

TESTING EQUIPMENT
Atlas Electric Devices Co. 912
Scott Testers, Inc. 952

TOGGLE CLAMPS
Detroit Stamping Company 980

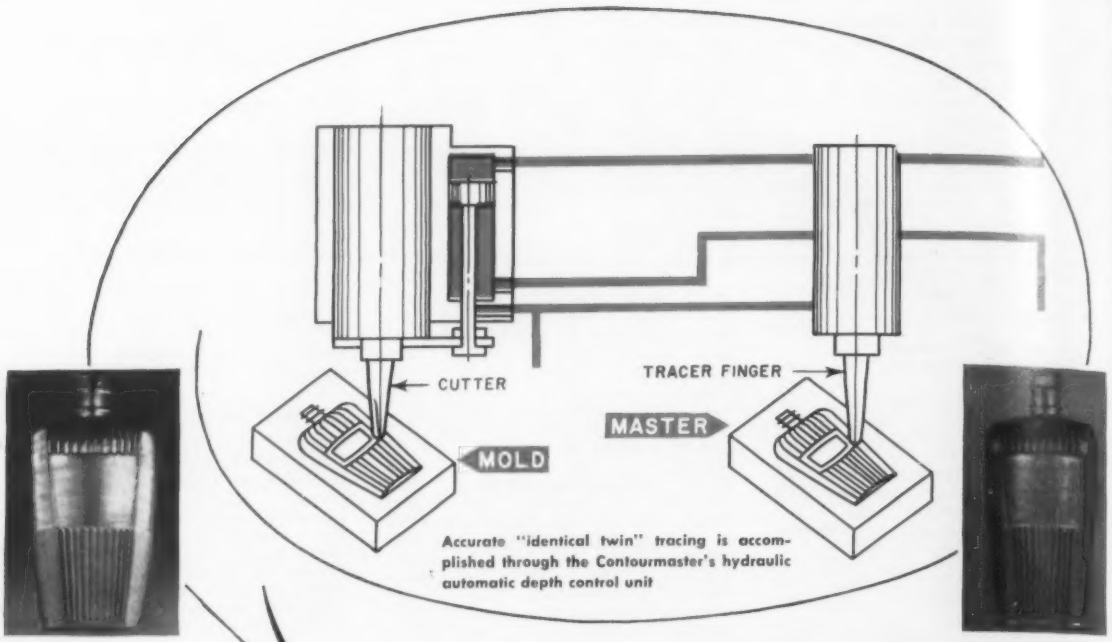
TRANSFER PRESSES
Adamson United Company .. 930, 931
B. I. P. Engineering Ltd. 960
Becker & Van Hullen 963
Bolling, Stewart, & Company, Inc. 868
Dunning & Boschert Press Co., Inc. 949
Elmes Engineering Division, American Steel Foundries 938, 939
French Oil Mill Machinery Co., The, Hydraulic Press Div. 985
Hull-Standard Corporation 955
Hydraulic Press Mfg. Co., The 878, 879
Improved Machinery Inc. 1013
Lake Erie Machinery Corp. 999
Lawton, C. A., Company, The ... 1006
M & N Modern Hydraulic Press Co., Inc. 1002
Stokes, F. J. Corporation 889
Triulzi, A. 940, 941
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951

VACUUM METALLIZING UNITS
Stokes, F. J., Corporation 889

VACUUM & SHEET FORMING MACHINES
Comet Industries 874
Negri Bossi & Co. 966

VALVES, SEALS
Sinclair-Collins Valve Company, The 1003
Taylor-Emmett Controls, Inc. . 956, 957
Wood, R. D., Company 918, 919

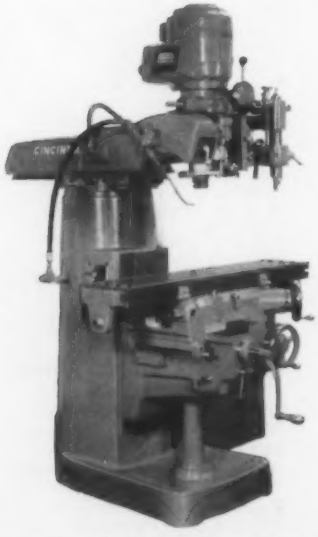
WINDERS, SPOOLERS, CORES
Black-Clawson Company, The, Dilts Div. 981
Dusenbery, John, Company 995
Faeco Machine Co., Inc. 952
Hobbs Manufacturing Co. .. 992, 1014
Production Metal Products Co., Inc. 980
Progressive Machine Co., Inc. ... 983
Robbins Plastic Machinery Corp. 968, 969
Waldron, John, Corporation .. 942, 943



Accurate "identical twin" tracing is accomplished through the Contourmaster's hydraulic automatic depth control unit

Identical Twins

. . .but One is a Low-Cost Contourmaster Reproduction of the Other



CINCINNATI CONTOURMASTER MILLING MACHINE
Catalog No. M-1919-2

Exact copy milling cuts hand finishing time; reduces cost to the bare essentials. Exact copy milling, and the low cost that goes with it, can be taken for granted when you assign your mold, die and hob work to CINCINNATI® Contourmaster Milling Machines. ¶ Contourmasters are equipped with sensitive hydraulic automatic depth control which automatically and accurately scans the vertical profile of the master. The cutter spindle follows the same path, producing an identical twin in metal. ¶ Other machining operations required to finish the mold can also be handled on Contourmasters. The spindle head can be swiveled forward and back; the table traverses 16" or 22"; cross traverse 10"; Shaping Attachment can be mounted on the ram and swiveled to position over the table when needed. Contourmasters are the finest tool and die milling machines for your shop. Write for catalog No. M-1919-2. Brief specifications in Sweet's Machine Tool File.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO

CINCINNATI

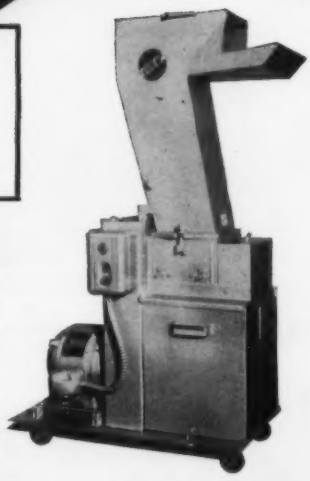
MILLING MACHINES • BROACHING MACHINES • CUTTER AND TOOL GRINDERS
METAL FORMING MACHINES • HARDENING MACHINES • OPTICAL PROJECTION
PROFILE GRINDERS • CUTTING FLUID • GRINDING WHEELS

INJECTION MOLDERS!

BOOST PRODUCTION!

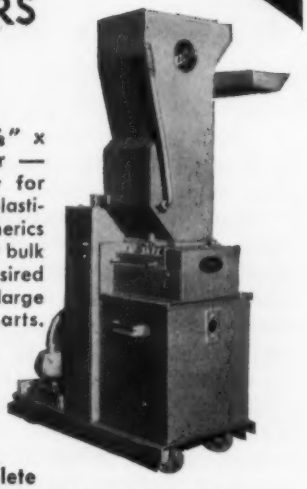
M-3 IMS M-4 GRANULATORS

All machines illustrated here in stock for prompt delivery.



The IMS M-3 6½" x 7" throat sprue grinder — rugged — simple in design — easiest to clean — built-in throat clearance bar — casters — catch pan.

PRICE: Complete with 1 HP Motor and Starter $598.50



The IMS M-4 5⅜" x 8½" throat grinder — designed primarily for vinyl, polyethylene, plastisols and all elastomerics where a fine-free low bulk factor product is desired — large throat for large injection molded parts.

PRICE: Complete with 2 HP Motor and Starter $788.50
Same, but with 3 HP Motor $854.00

CONSTANT MOLD TEMPERATURE REGULATOR



The IMS Economy Circulator — **priced at only $369.50 complete (oil model for heats to 450° at $482.50)** — duplicates performance of mold heaters costing up to 6 times as much — developed by a molder for molders — compact — portable only 15" x 22½" floor space.

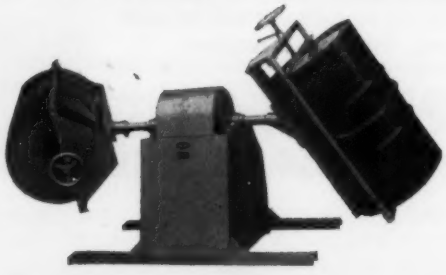
NOTE: Special price for 2 units ..... $349.50 Each

Send for our 1957 Nozzle Catalog and Heater Band Book Today. You'll find all styles of nozzles and heater bands fully described and priced, with technical notes on nylon molding.

Prompt service on all kinds of nozzles by the world's largest and most experienced nozzle specialists.

IMS DRUM TUMBLERS

FOR ALL COLORING AND MIXING OPERATIONS



All IMS Drum Tumblers are based on design suggestions of the leading material and colorant suppliers. Available for immediate shipment from stock.

¾ HP Model **$595.00**
(Takes drums up to 33" high x 22" in diam.)
2 HP Model **$897.50**
(Takes drums up to 37" high x 23¼" in diam.)
3 HP Model **$1285.00**
(Takes drums up to 45" high x 24" in diam.)

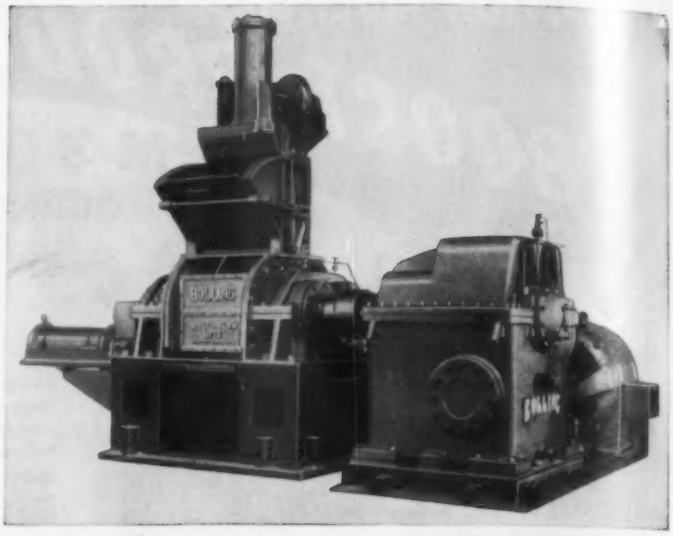
INJECTION MOLDERS SUPPLY CO.

3514 LEE ROAD, WYoming 1-1424
CLEVELAND 20, OHIO

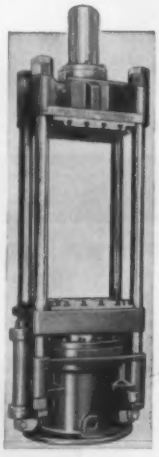
PRODUCTION and LABORATORY MACHINERY

PLASTICS • RUBBER

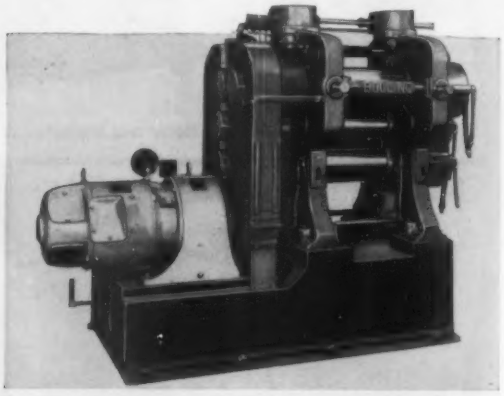
Have you investigated the wide scope of Stewart Bolling equipment? . . . Bolling *intensive mixers* embody exclusive Spiral-Flow removable side construction. The new compound drive, illustrated at the right, permits speeds and power heretofore not attained on any other mixer. . . *Presses* are made in many sizes and types, signifying an experience unparalleled in this field. . . . A broad range of roll sizes and frame designs is offered in the Bolling line of *calenders*. . . Today's largest line of *laboratory mills* is found at Bolling because of our pioneering and specializing in this restricted but crucial phase of production. Bolling *production mills* have long since established themselves as featuring operating convenience and safety with minimum maintenance. . . A catalog on each basic line of equipment will be sent upon your letterhead request.



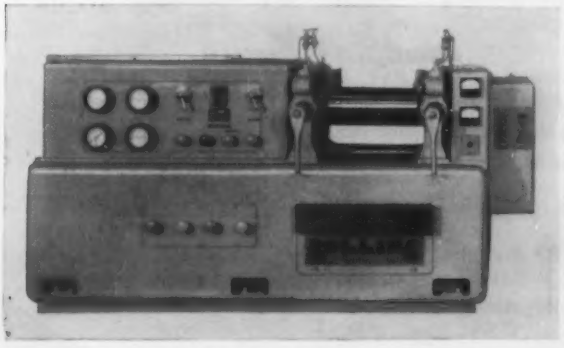
MIXERS *Above is No. 10 with compound drive. Six sizes from 231 to 16000 cu. in. chamber capacities offered.*

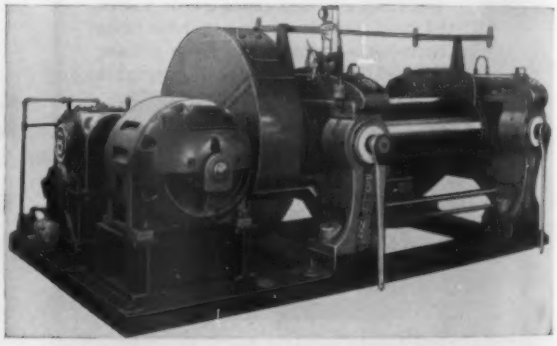


PRESSES *Transfer and compression molding presses from 50 to 2500 tons, 14" x 14" through 42" x 42".*



CALENDERS *Above is 4-roll, 8" x 16" lab-production model. 2-, 3- and 4-roll from 8" dia. through 22" dia. rolls, 16" through 66" face.*





MILLS *Above left is an 8" x 20" deluxe laboratory model. Right above is a 22" x 60" production size. Eleven sizes from 2½" dia., 7" wide rolls, through 26" dia., 100" width.*

STEWART BOLLING & COMPANY, INC.

3196 EAST 65TH STREET • CLEVELAND 27, OHIO

• INTENSIVE MIXERS AND MILLS • CALENDERS • REFINERS • CRACKERS HYDRAULIC PRESSES • PUMP UNITS BALE SLITTERS • SPEED REDUCERS

NRM Thermoplastics EXTRUDERS

offer the plastics industry

advanced design, construction and operating features like these . . .

1. ***BALANCED HEAT CONTROL—***
This patented NRM feature assures the *uniform* heating which results in closer-tolerance extrusions of finer finish and shape holding quality.

2. ***"CAST IN" CYLINDER HEATING—***
The aluminum body of the heater is cast around the heating element, enclosing it completely. Possibility of any kind of failure is virtually eliminated. In addition to longer life, they offer quicker response to controls than other types of cylinder heaters.

3. ***AUTOMATIC DIE HEAD CLAMPS—***
Air (or hydraulic) cylinders *instantly* lock the die head, making a leak-proof seal . . . or as quickly release it to speed up cleaning or die and screen changing on large NRM Extruders (6" to 15").

4. ***20:1 RATIO ONE-PIECE CYLINDERS—***
With effective cylinder and screw lengths twenty times their diameter, more intensive heating and greater mechanical working of the plastic is provided. Results are top quality extrusions produced with less waste 30 to 50% faster than with extruders having shorter cylinders.

5. ***SINGLE-WALL XALOY CYLINDER LINING—***
For more compact, more durable extruder construction. Corrosion-resistant Xaloy 306 assures long cylinder life with original dimensions maintained.

6. ***JOB DESIGNED FEED SCREWS—***
NRM patented Torpedo Screws improve both quantity and quality of plastics production by thorough mixing, evenly distributing heat through the compound, and by obtaining uniform cross-sectional pressure at the die. NRM has a screw type to meet all extruding requirements.

7. ***J.I.C. CODED ELECTRIC CONTROL CABINETS—***
Precision-engineered and quality-constructed, giving you wiring to a universal standard, labeled circuits, and all wiring completed to terminals. J.I.C. Control Cabinets are Standard NRM equipment.

8. ***MATCHED DIES AND ACCESSORIES—***
NRM makes available dies and haul-off equipment designed specially for the type of extrusion, and to utilize to the fullest, the high production capacities of NRM Extruders.

THERE'S AN NRM WITH DIES AND ACCESSORIES TO HANDLE EVERY EXTRUDING REQUIREMENT . . .

From small 1" Laboratory Bench Models to big 15" high-capacity Extruders with Automatic Die Head Clamps, *all* have the same quality features that make NRM Extruders most profitable to operate, and which *sustain* profitable operation over many years of trouble-free service. The Extruders and equipment shown below and on following pages are representative only of the NRM *full* line. Check them over and contact us for more details today. There's an NRM of the right type and size to handle every extruding requirement.

NRM MODEL 55 2-1/2" EXTRUDERS

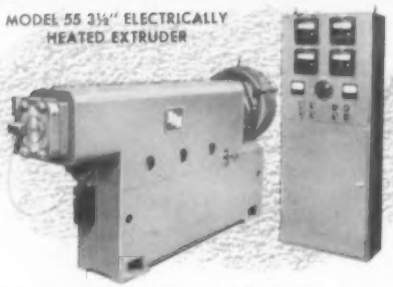
NOMINAL CAPACITY: 80-115 lbs./hour—SCREW SPEED: 11-72 rpm. Minimum Range—DRIVE: 15 hp—REDUCTION UNIT: Cone Worm Gear—15:1 Ratio—FLOOR SPACE: 89⅞" long x 25" wide (Extruder only), 22" deep x 38" wide (Control Cabinet), 38" long x 27½" wide (Oil Heating Unit)

	Electric	Oil	Steam
Max. Operating Temperatures:	650°F	575°F	250 psi
Temperature Controls:	Proportioning Pyrometer	Electric & Manual Control	None Furnished



NRM 2½" ELECTRICALLY HEATED EXTRUDER WITH OFFSET PIPE DIE

NRM MODEL 55 3-1/2" EXTRUDERS


MODEL 55 3½" ELECTRICALLY HEATED EXTRUDER

NOMINAL CAPACITY: 160-230 lbs./hour—SCREW SPEED: 12-73 rpm, Minimum Range—DRIVE: 25 hp—REDUCTION UNIT: Herringbone Gear—24.5:1 Ratio—FLOOR SPACE: 112" long x 36" wide (Extruder only), 22" deep x 38" wide (Control Cabinet) 38" long x 27½" wide (Oil Heating Unit)

	Electric	Oil	Steam
Max. Operating Temperatures:	650°F	575°F	250 psi
Temperature Controls:	Proportioning Pyrometer	Electric & Manual Control	None Furnished

NRM MODEL 55 6" EXTRUDERS


MODEL 55 6" ELECTRICALLY HEATED EXTRUDER

NOMINAL CAPACITY: 450-675 lbs./hour—SCREW SPEED: 6-72 rpm, Minimum Range—DRIVE: 100 hp—REDUCTION UNIT: Herringbone Gear—24.5:1 Ratio—FLOOR SPACE: 177" long x 48" wide (Extruder only), 22" deep x 38" wide (Control Cabinet), 38" long x 27½" wide (Oil Heating Unit—3 req'd)

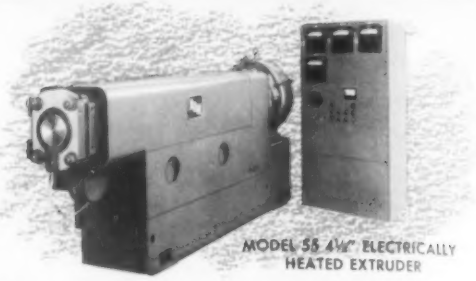
	Electric	Oil	Steam
Max. Operating Temperatures:	650°F	575°F	250 psi
Temperature Controls:	Proportioning Pyrometer	Electric & Manual Control	None Furnished

NRM MODEL 55 1-1/2" EXTRUDERS

NOMINAL CAPACITY: 30-35 lbs./hour—SCREW SPEED: 10-71 rpm — DRIVE: 3 hp — REDUCTION: Chain Drive—FLOOR SPACE: 49" long x 19" wide (Extruder with Drive). 10" deep x 20" wide (Control Cabinet)—MAX. OPERATING TEMPERATURE: 650°F—TEMPERATURE CONTROLS: Proportioning Pyrometer Type.


1½" ELECTRICALLY HEATED 20:1 Le/D RATIO EXTRUDER

NRM MODEL 55 4-1/2" EXTRUDERS


MODEL 55 4½" ELECTRICALLY HEATED EXTRUDER

NOMINAL CAPACITY: 275-375 lbs./hour—SCREW SPEED: 9-75 rpm, Minimum Range—DRIVE: 50 hp—REDUCTION UNIT: Herringbone Gear—24.5:1 Ratio—FLOOR SPACE: 143" long x 39" wide (Extruder only), 22" deep x 38" wide (Control Cabinet), 38" long x 27½" wide (Oil Heating Unit—2 req'd)

	Electric	Oil	Steam
Max. Operating Temperatures:	650°F	575°F	250 psi
Temperature Controls:	Proportioning Pyrometer	Electric & Manual Control	None Furnished

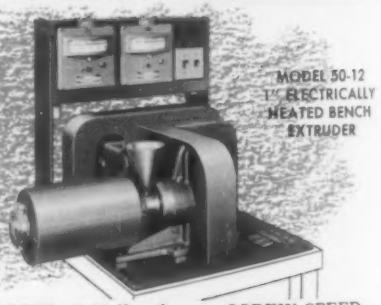
NRM SPECIAL 8" EXTRUDER



This 8" Electrically Heated Extruder is typical of how NRM can incorporate in a single machine, standard proven design features to obtain a "custom" installation. This *standard* Extruder has Automatic Die Clamp, special screw and special electrically heated cable covering crosshead.

NRM 1" BENCH MODEL EXTRUDERS

For Laboratory and Light Production Work


MODEL 50-12 1" ELECTRICALLY HEATED BENCH EXTRUDER

NOMINAL CAPACITY: 6-10 lbs./hour—SCREW SPEED: 21-136 rpm—DRIVE: ¾ hp Variable Speed—REDUCTION UNIT: Combination Gears and Belts—BENCH SPACE: 34⅞" long x 27" wide.

	Electric	Oil
Max. Operating Temperatures:	650°F	575°F
Temperature Controls:	Proportioning Pyrometer Thermostatic	

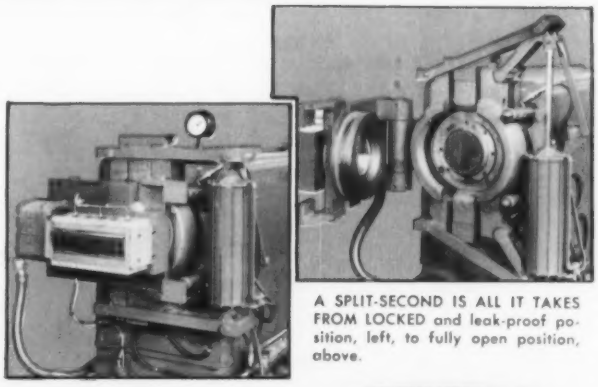
EXTRUDERS WITH *AUTOMATIC* DIE HEAD CLAMPS

The latest engineering refinement contributing to easier and faster operation of large NRM Extruders (6″ to 15″) is the Automatic Die Head Clamp. Touching a lever *instantly* locks the head with a positively leak-proof seal, or as quickly unlocks it for quick screen changing or cleaning. In addition to time and labor saving features, other advantages of the Automatic Clamp are:

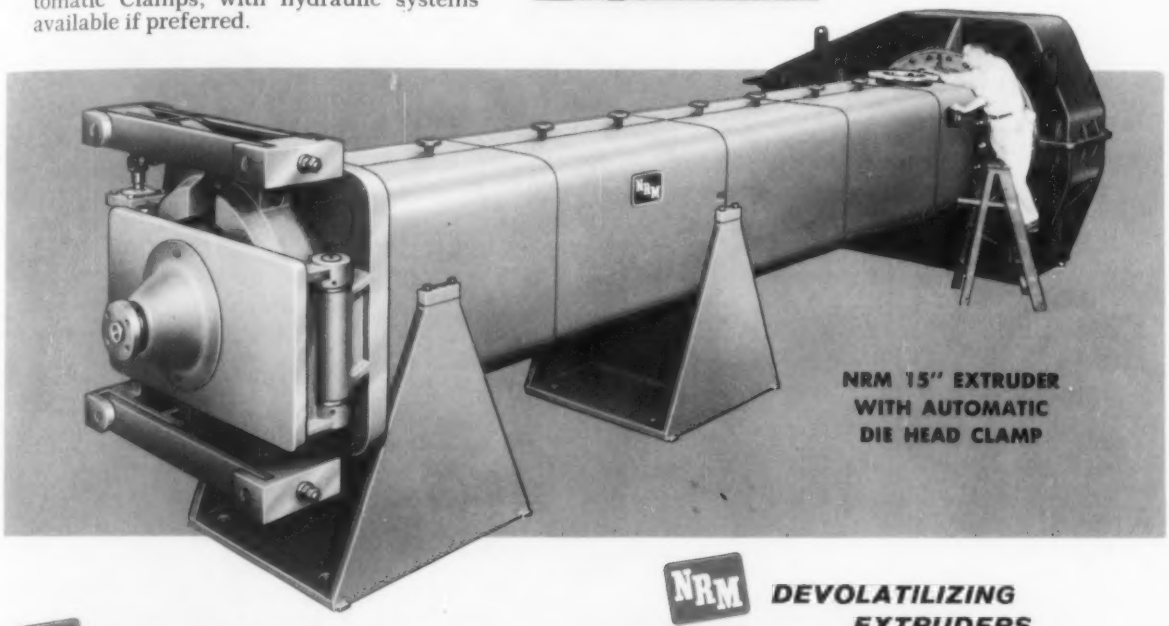
POSITIVE SEALING—no leakage of material around the head.

FOOLPROOF ACTION — simplicity and compactness makes it completely dependable.

PNEUMATIC CYLINDERS power the Automatic Clamps, with hydraulic systems available if preferred.

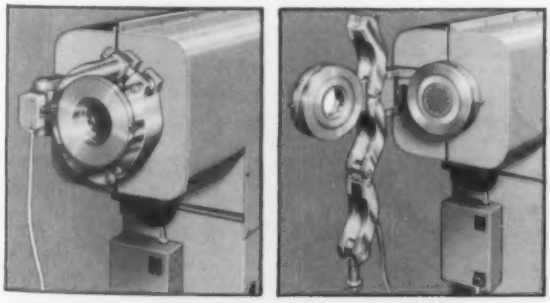


A SPLIT-SECOND IS ALL IT TAKES FROM LOCKED and leak-proof position, left, to fully open position, above.



NRM 15″ EXTRUDER WITH AUTOMATIC DIE HEAD CLAMP

EXTRUDERS WITH "HANDY CLAMP DIE HEADS"



Manually operated "clamp-type" die heads are available for 1½″, 2½″, 3½″ and 4½″ NRM Extruders on request. From leak-proof closed and locked position (left) they may be unlocked and opened (right) by loosening the single swing bolt shown. Note the rugged construction.

DEVOLATILIZING EXTRUDERS



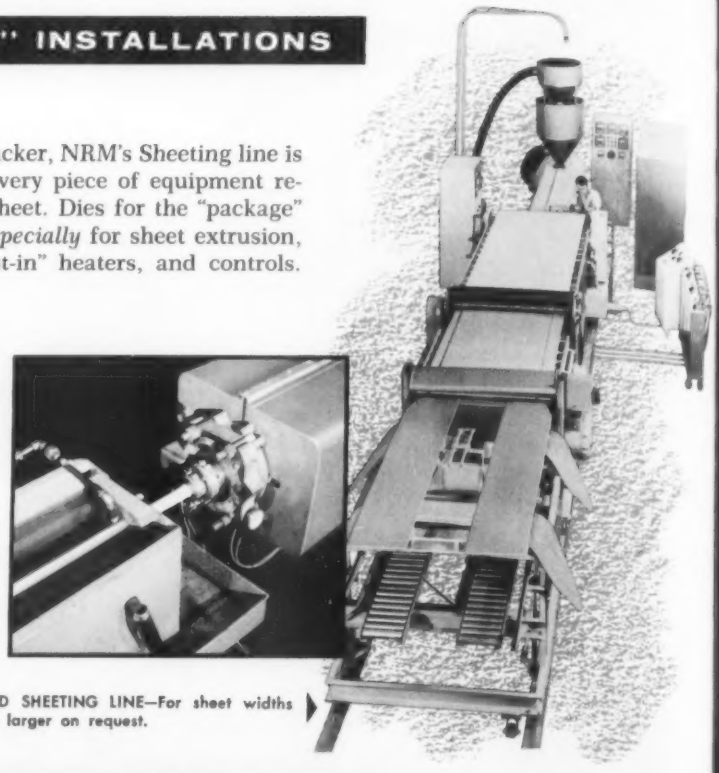
NRM 4½″ DEVOLATILIZING EXTRUDER

These Extruders make use of a special patented, adjustable valve, and a large vent to remove moisture and gases from plastics which must be vented to prevent porosity. Typical are cellulose, acetate and butyrate, ethyl cellulose acrylic and vinyl pellet and powder blends . . . especially when used for wire covering. They are obtainable in all sizes and may be electric, oil or steam heated.

NRM "PACKAGED" INSTALLATIONS

FOR RIGID SHEET—From Extruder to stacker, NRM's Sheeting line is a self-contained unit which includes every piece of equipment required for production of rigid plastic sheet. Dies for the "package" are extremely rugged, are engineered *specially* for sheet extrusion, and are furnished complete with "cast-in" heaters, and controls. Write for full details.

FOR PLASTIC PIPE — Standard Units consist of Extruder, Die, Cooling Tank, Take-up, Cut-off, and/or Wind-up. Complete unit not shown. Write for full details.



NRM RIGID SHEETING LINE—For sheet widths up to 48", larger on request.

NRM DIES AND ACCESSORIES

VERTICAL TUBING DIES
Size range: 1" to 12" inclusive, for extrusion of blown P.V.C. and Polyethylene film.

ANNULAR TUBING DIES
Size range: 14" to 36", other sizes on request, for extrusion of large blown film tubing.

PIPE DIES
Size range: ½" to 6" I.P.S. Straight delivery and offset types available for extrusion of rigid P.V.C., Polyethylene, Acetate Butyrate and Kralastic pipe.

TEE-TYPE DIES
Size range: 12" to 96", for extrusion of flat Polyethylene film and Polyethylene laminating.

SHEETING DIES
Size range: 24" to 48" widths, gauges, .040" to .180, other sizes and gauges on request. Three styles available for extrusion of Acrylic, high impact Polystyrene, Acetate, Acetate Butyrate, Kralastic, Polyethylene and P.V.C., rigid and elastomeric.

NRM ACCESSORIES include Conveyors, Cooling Tanks, Pipe Haul-Offs, Blown Film Take-ups, and others. Write for details.

WRITE TODAY
for more details, quotations, demonstrations or engineering assistance. Our extensive laboratory facilities are available to help solve your extrusion problems.

OTHER SIZES FOR ALL DIES AVAILABLE ON REQUEST

NATIONAL RUBBER MACHINERY COMPANY

General Offices and Engineering Laboratories: 47 West Exchange St., Akron 8, Ohio—HE 4-1961

EAST: 384 Getty Ave., Clifton, N. J.—PRescott 7-7500
SOUTH: The Robertson Company, Rutland Building, Decatur, Ga.
WEST: S. M. Kipp, Box 441, Pasadena 18, Cal.—SYcamore 4-2110
MID-WEST: National Rubber Machinery Co., 5875 N. Lincoln Ave., Chicago 5, Ill.—LOngbeach 1-0328
CANADIAN: F. F. Barber Machinery, Ltd., 187 Fleet St., West, Toronto, Ont.
EXPORT: Omni Products Corporation, 460 Fourth Ave., New York, N. Y. —LExington 2-1320.

38.5M—2783-757—Printed in U. S. A.

Plants at: AKRON, COLUMBIANA AND LEETONIA, OHIO — CLIFTON, N. J.

Sterlco® TEMPERATURE CONTROL UNITS

THE LOGICAL CHOICE OF EQUIPMENT MANUFACTURERS, MATERIAL SUPPLIERS and PLASTICS PROCESSORS for FASTER PRODUCTION, FINER PRODUCTS and FEWER REJECTS



MODEL 6002

The DUAL mobile temperature control unit functioning in leading plastics plants from coast to coast. Ready to operate when connected to electricity, water, and drain.



MODEL 6003

A compact DUAL unit designed for permanent installations. (Can be equipped with casters.) Requires less floor space than Model 6002 with some capacities.



MODEL 6012

A compact, efficient SINGLE unit designed to do the typical Sterlco job of temperature control where a single stabilized temperature is adequate. Can be combined with Sterlco Model 6002 and 6003 Dual units where more than two temperatures are required.

only Sterlco® offers

- Super-fast 9000 watt heating units for quick starts.
- Small total water capacity, — no excess thermal carryover either way.
- Super-sensitive, accurate *heating control* with extremely fast reaction time.
- Flexible, modulating *cooling control* — not on or off.



MODEL 6007

HIGH TEMPERATURE DUAL OIL CIRCULATING UNIT — The Model 6007 assures accurate control from 100° to 500° F. The Model 6007 is a dual unit, affording interchangeable double capacity for all applications where steady, accurate high temperature control is necessary.

MODEL 6016—HIGH TEMPERATURE SINGLE OIL CIRCULATING UNIT — A compact SINGLE unit with the same basic features as Model 6007 plus choice of heater capacity.



MODEL 6031

TRIPLE TEMPERATURE CONTROL UNIT — This unit was specially designed for use in the manufacture of plastic sheet. It provides accurate temperature control for molds and rolls with provision for temperatures up to 240° F.

Sterlco Engineers are always available to assist you in the selection of proper temperature control equipment . . . write today!



MODEL 7000

COOLING AND CIRCULATING UNIT— *Where cooling only is required.* This unit accurately and automatically does the work without any guesswork and without wasteful "on and off" valves. Same operating features as Models 6002, 6003, and 6012 but without provision for heating. Excellent for use at sprue section of large molds.

REPRESENTATIVES IN PRINCIPAL CITIES

Export: OMNI PRODUCTS CORPORATION • 460 Fourth Ave. • New York 16, N. Y.

MANUFACTURERS OF TEMPERATURE CONTROL EQUIPMENT SINCE 1916

INDUSTRIAL CONTROL DIVISION

STERLING, INC.

3736 N. Holton St., Milwaukee 12, Wisconsin

A COMPLETE LINE



Temperature Controls



Thermostatic Traps



Condensation and Vacuum Pumps

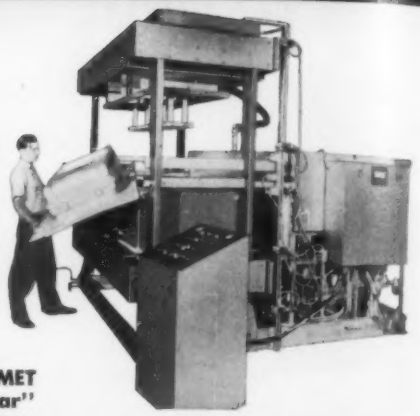
TURN OUT more production

. . . with a "Comet" PLASTIC SHEET FORMING MACHINE



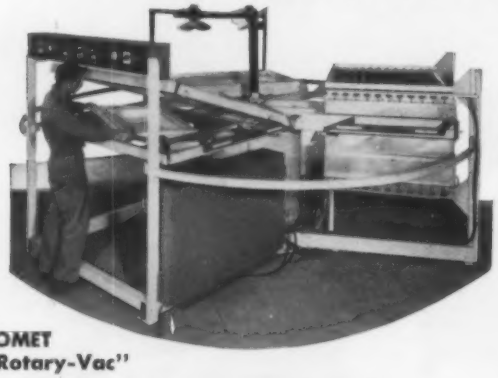
COMET "Twin"

Two complete and individually controlled Drape and Vacuum Forming Machines built into a common frame using one vacuum source and heating unit. This construction and design has resulted in the utmost in productivity and reduced costs. A real leader in the industry.



COMET "Star"

New Forming Techniques incorporated into one machine for the first time: **Snapback Forming—Mechanical Forming—Pressure Forming—Airslip Forming—Vacuum Forming and Trimming in One Operation.** Counteracting platens have positive control of Plastic Sheet during forming operations. Available in 4 sizes with either single or double forming press.



COMET "Rotary-Vac"

VACUUM, DRAPE AND AIRSLIP FORMING
200% GREATER PRODUCTION—Operator Loads and Unloads at One Station—All Other Operations Fully Automatic.

- Fast and easy to set-up.
- Enclosed oven with heating from 2 sides.
- Safe—simple to operate.
- Rugged and dependable construction.
- Stroke 17".

ALSO AVAILABLE WITH MALE ASSIST.

COMET "Meteor" Automatic

BLISTER & SKIN PACKAGING

FOR . . .
PRODUCTION
TEST WORK
MODELS
SHORT RUNS

Unparalleled flexibility and economy.



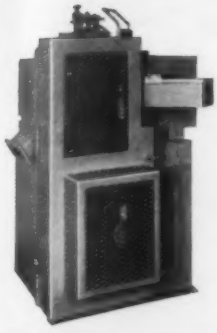
- Form-Drape-Draw to 15" deep.
- New Design rapidly adjusted clamp frame eliminates plastic pull-out.
- Use coils, sheets or small blanks—thickness from .001" to .250".
- Shipped complete-ready for operation.

Special Machines Designed to your needs. Write for bulletin MPE7.

Designed and Manufactured by **Comet INDUSTRIES**
9863 Franklin Avenue
FRANKLIN PARK, ILLINOIS, U.S.A.

CUMBERLAND
Plastics Size-Reduction Machinery

Cumberland "Stair-Step" Dicing Machines



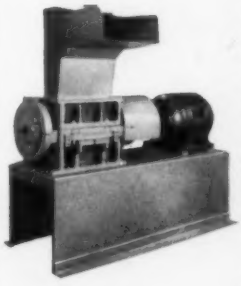
For dicing the *full range* of thermoplastic materials.

Cubes 1/16" to 1/2" produced from plastic sheet or ribbon stock. Pellet sizes altered merely by changing knives. Cubing is done in one severing operation with rotor knives cutting against one bed knife.

All surfaces contacting plastic materials are of corrosion-resistant metals.

Two sizes of machine available to handle sheets up to 7" and 14" in width.

Cumberland Model 20 All Steel Granulator

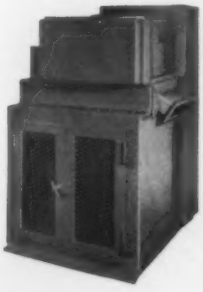


This heavy-duty all steel machine with 8" by 20" throat opening is suited for granulating tough plastic materials in the form of slabs, bleeder scrap, cylinder purgings, heavy cross-sectional parts, etc.

Frame and cutting chamber are of thick weldments with deep welds. Rotor and seal rings are heat treated and ground all over to provide tough, undamageable parts. Hardened surfaces preserve new appearance.

Machines resist wreckage. All inner surfaces are ground smooth to provide ease of cleaning.

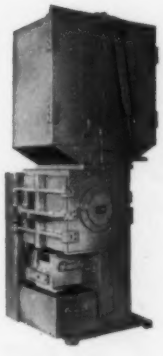
Cumberland Pelletizing Machines



A versatile machine designed for use as a pelletizer, chopper or dicer. As a pelletizing machine: cuts multiple extruded strands of plastic material into cylindrically shaped pieces or cubes for use in molding or extrusion machines. As a notched knife dicing machine: handles principally vinyl sheet stock. A less expensive dicing machine although less universal than the Cumberland "Stair-Step" Dicer. As a chopping machine: efficiently cuts rubber and vinyl slabs into small pieces.

Available in two sizes to handle stock widths up to 14" or 24".

Cumberland Pre-Breaker Granulators



Universal in its application, this dual rotor machine combines a pre-breaking machine and granulating machine in one compact unit. A large throat opening is provided to accommodate bulky reclaim as vacuum formed parts or trim. Also handles extra large and bulky parts and pieces of heavy cross-section as bleeder reclaim slabs, purgings, etc.

A special dome added to top of hopper makes machine ideal for long lengths of extruded pipe, rods, contours and similar items.

Unique hopper prevents any flyback.

Available in two sizes with 12" x 24" or 24" x 48" throat opening.

GRANULATING MACHINES
For Central Granulating and Use Beside the Injection Press

CUMBERLAND MODEL 0 — V-Belt or Direct Coupled (2 models)
For use beside each injection molding machine. Also for laboratory and miscellaneous uses.
Motor: 1½ or 2 h.p. Throat: 3¾" x 5½"

CUMBERLAND MODEL ½ — V-Belt or Direct Coupled (2 models)
For use beside each injection molding machine. Also for laboratory and miscellaneous uses.
Motor: 3 h.p. Throat: 4" x 8½"

CUMBERLAND MODEL 1½ — Direct Coupled
For central granulating use.
Motor: 10 h.p. Throat: 5" x 12" or 8" x 11"

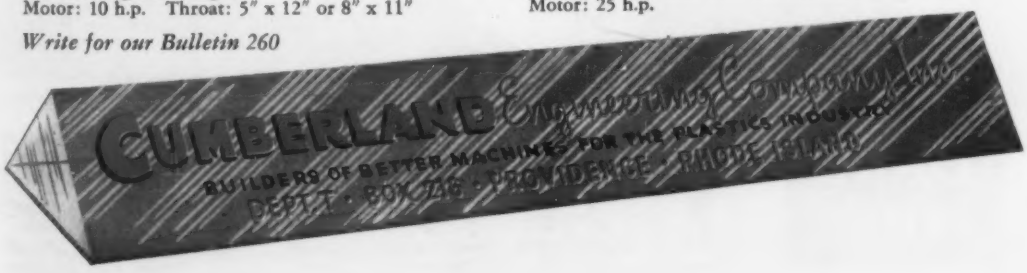
CUMBERLAND MODEL 10 — V-Belt Drive
For use principally beside the injection press.
Motor: 3 or 5 h.p. Throat: 6" x 10"

CUMBERLAND MODEL 18 — Direct Coupled
For central granulating use.
Motor: 20 h.p. Throat: 5" x 18" or 8" x 18"

CUMBERLAND MODEL 20 — (illustrated above)

CUMBERLAND FINE GRANULATING MACHINE
A machine for granulating to a higher degree of fineness than is possible with conventional machines.
Motor: 25 h.p.

Write for our Bulletin 260

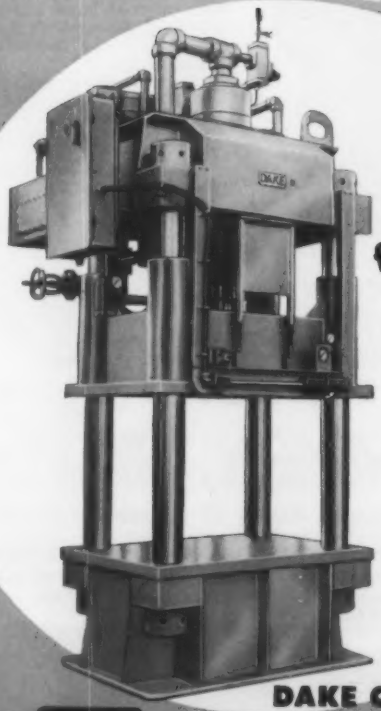


available in standard and custom engineered models



for trimming and piercing vacuum-formed plastics

DAKE HYDRAULIC PRESSES



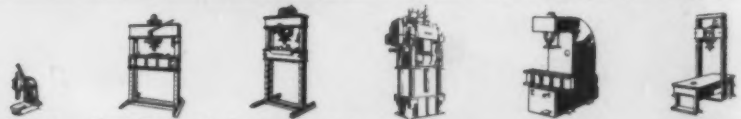
for molding reinforced plastics

Be a pacemaker in the fast-moving plastics industry with equipment designed to keep production geared to modern trends. Dake Hydraulic Presses speed output and reduce costs. They are job-engineered by men experienced in the plastics industry. These men are ready to help you meet special requirements as well as provide better equipment . . . both for compression molding of reinforced plastics as well as trimming and piercing vacuum-formed plastics. Standard models are electric-hydraulic in operation, with capacities ranging from 25 to 300 tons. They are adjustable for stroke, pressure, temperature and timing. Dual palm-operated controls are standard, providing safety in operation. Dake will gladly work with you in developing whatever special press equipment you need.

For descriptive literature on these presses, write for Bulletins 340 and 352.

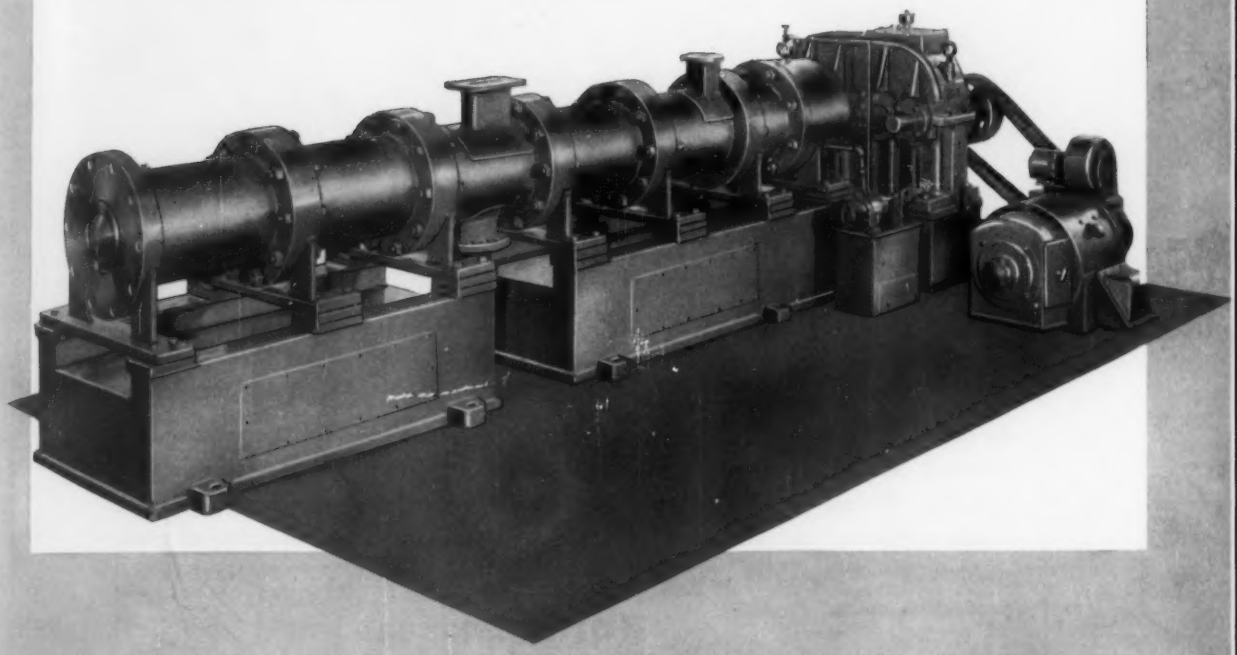
DAKE CORPORATION 641 Monroe St., Grand Haven, Michigan

DAKE PRESSES



Arbor Presses | Hand-Operated Hydraulic | Power-Operated Hydraulic | Guided Platen | Gap Type Presses | Movable Frame

Specials... THAT'S US



The 8" extruder illustrated fits into a special processing line. Custom designed for a large chemical company, the extruder had to be designed to coordinate with existing processing, blending and mixing facilities.

Extruders for standard operations can be off-the-shelf models but new processes, new products, new ideas require specific designs. For example, in the processing of polyethylene, we developed special extruders for simultaneous hot and cold feeding. In the fields of foamed plastics, polystyrene, polyethylene, the vinyls, we have designed many individual extruders for processing, blending, reclaiming and devolatilizing.

Most new ideas for special equipment originate in shirt-sleeve sessions with a company's production and engineering personnel. They know their process requirements. We translate these specifications into machines tailored to the job.

If you are working on new ideas in either plastics or rubber, H & K can be of assistance. We have specialized knowledge of these fields and can design a complete plant, a special process or an individual machine. We also have complete engineering service.

YOUR INQUIRY

For prompt response, please address your inquiry to:

Hale and Kullgren, Inc.
613 E. Tallmadge Ave. Akron, Ohio

Sales and Engineering by

HALE and KULLGREN, INC.

P. O. Box 1231 · AKRON, OHIO

MANUFACTURED BY

THE AETNA-STANDARD ENGINEERING CO., PITTSBURGH, PA.

PLANTS IN WARREN, OHIO · ELLWOOD CITY, PA.

HPMs FOR EVERY MOLDING JOB

THE MOST COMPREHENSIVE LINE OF PLASTIC MOLDING EQUIPMENT

Choose the method best suited to your needs, then select an H-P-M press to do the job! From the first acceptance of plastics as a highly feasible commercial material, H-P-M has been designing and building molding machines for the plastic industry. Today, H-P-M offers plastics machines for every job—injection, compression, transfer, laminating and reinforced plastics — machines designed to give molders larger capacities . . . faster cycles . . . fewer rejects . . . big savings in production costs.

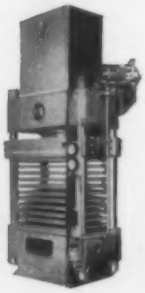
Regardless of your molding application, you'll handle the job better and faster with an H-P-M. Investigate now how an H-P-M will help your production. There's an H-P-M plastics engineer as near as your telephone . . . call him today.

REINFORCED



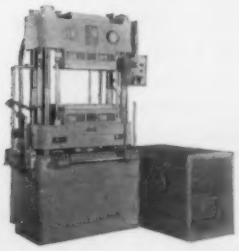
A complete line of stock presses from 50 to 200 tons, designed specifically for molding reinforced plastics. Larger sizes built to order. Write for Bulletin No. 5404!

LAMINATING



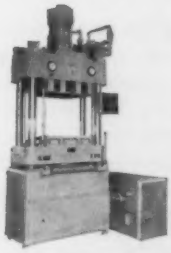
Multiple hot plate presses with steam or electrically heated plates for compressing or curing laminated material. Built to customer's requirements.

COMPRESSION

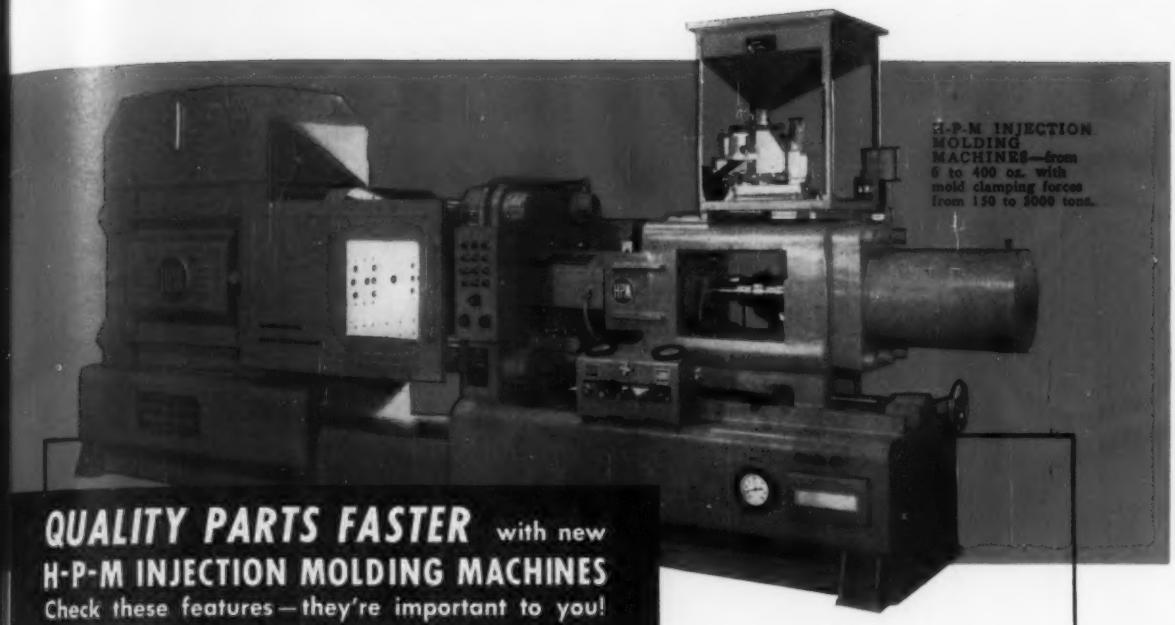


Stock sizes 100, 200, 300 and 500 tons. Larger sizes up to 2500 tons built on special order. Write for Bulletin No. 5702!

TRANSFER



Stock sizes 100, 200, 300 and 500 tons. Larger sizes up to 2500 tons built on special order. Write for Bulletin No. 5702!



H-P-M INJECTION MOLDING MACHINES—from 6 to 400 oz. with mold clamping forces from 150 to 3000 tons.

QUALITY PARTS FASTER with new H-P-M INJECTION MOLDING MACHINES

Check these features—they're important to you!

- **Full Hydraulic Mold Clamp**
- **Large Platens With Plenty of Stroke and Daylight**
- **Over-Capacity Heating Cylinders**
- **Greater Horsepower With Faster Injection Speeds**
- **Manifold Valve System Reduces Hydraulic Piping**
- **Overhead Oil Tank**
- **New Hydraulic System Incorporating Flange Mounted Vickers and Denison Pumps**

SPECIFICATIONS

Model	200 H 6/8	300 HV 12/16	450 HV 20/28	650 HV 32/42	800 HV 48/64	Long Stroke 800 HV 48/64	1200 H 80/100	Long Stroke 1200 H 80/100
Material Injected Per Cycle (oz.)	6-8	12-16	20-28	32-42	48-64	48-64	80-100	80-100
Material Injected (Cu. In. Per Min.)	675	1130	1530	2510	2800	2800	2850	2850
Plasticizing Capacity (Lbs. Per Hr.)	80	135	200	300	300	300	400	400
Mold Clamp Capacity (Tons-Max.)	200	300	450	650	800	800	1200	1200
Platen Size (In.)	26x26	30x33	36x42	48x48	55x55	55x55	60x68	60x68
Clearance Between Tie Rods (In.)	15½x15½	17½x20½	21x27	30½x30½	36½x36½	36½x36½	40½x48½	40½x48½
Daylight Opening (Max.) Without Ram Spacer (In.)	25	30	40	50	55	84	60	104
Daylight Opening (Max.) With Ram Spacer (In.)	21	26	34	42	47	76	48	92
Mold Thickness (Min.) Without Ram Spacer (In.)	10	10	15	20	20	30	24	44
Mold Thickness (Min.) With Ram Spacer (In.)	6	6	9	12	12	22	12	32
Clamp Travel (Max.)	15	20	25	30	35	54	36	60
Motor Horsepower	30	45	75	107½	127	127	100	100
Shipping Weight (Lbs.)	16,500	27,000	41,000	76,000	87,000	98,000	135,000	152,000

NOTE: All injection capacities specified above are for general purpose polystyrene.

H-P-M PREPLASTICIZING MACHINES AND CONVERSION UNITS ARE AVAILABLE UP TO 400 OZ. CAPACITIES



WRITE FOR BULLETIN NO. 5701 Today!

THE HYDRAULIC PRESS MFG. CO.

A DIVISION OF KOEHRING COMPANY

Mount Gilead, Ohio

HPM

when you consider new

INJECTION MOLDING MACHINES

from 4 to 60 Ounces...

be sure to check the advantages of LESTERS. The unique features of all standard machines (plus 14 optional auxiliary circuits for special jobs) give a flexibility of use that is unequaled in the field.

Want complete specifications? Write today for Bulletin 202.



LESTERS



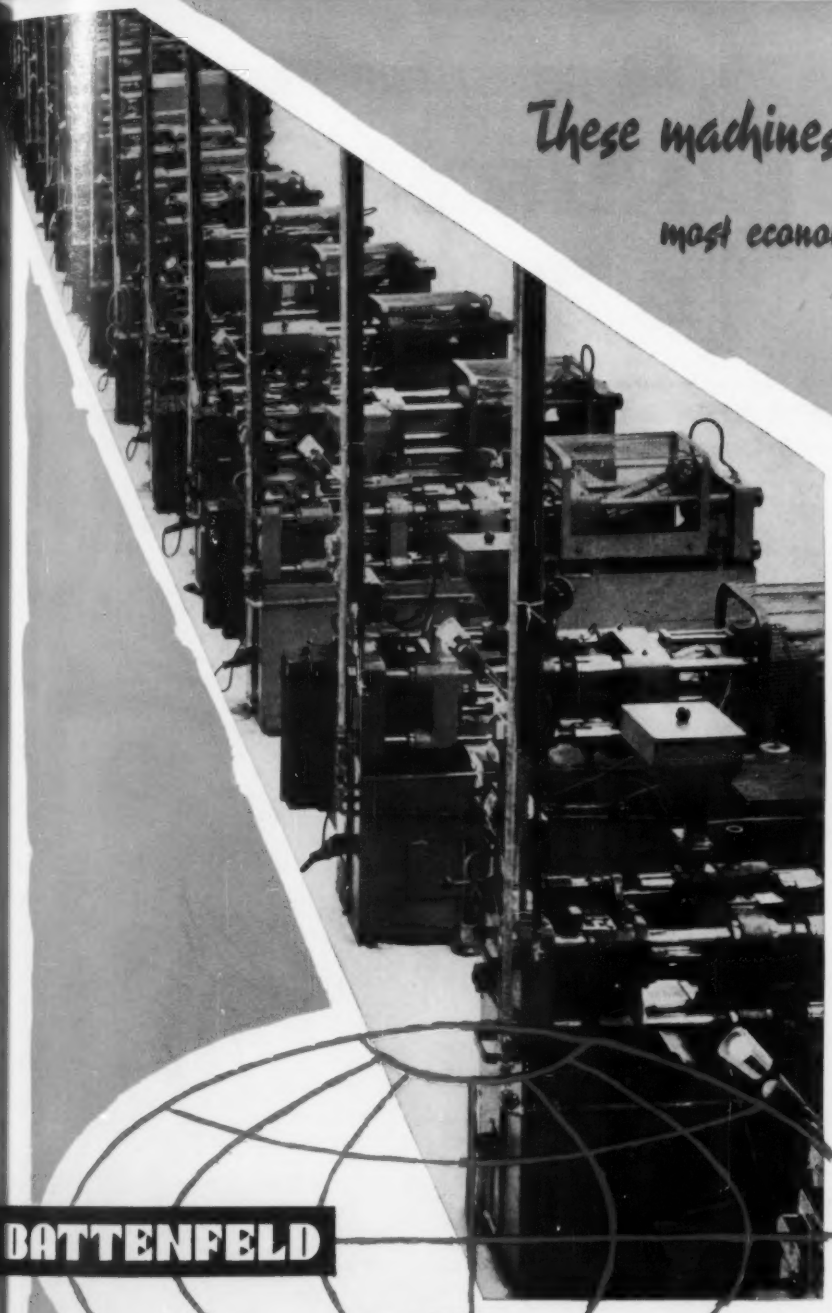
LESTER-PHOENIX, INC.

2657 CHURCH AVENUE • CLEVELAND 13, OHIO

Agents in principal cities throughout the world

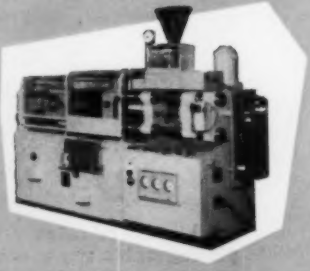
These machines give

most economical production



BATTENFELD

The fully automatic operation, simple electro-mechanical design with an amazing record of quality maintained over long production runs at lowest initial and lowest operating costs are the outstanding characteristics of BATTENFELD INJECTION MOLDING MACHINES



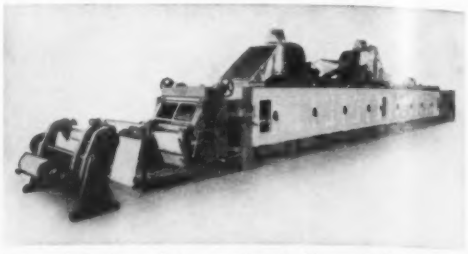
More than 2000 Battenfeld INJECTION MOLDING MACHINES are operating in 48 countries all over the world

Sole agents for sales and service MOLDING SYSTEMS INC. DANIELSON, CONNECTICUT

SPECIAL MACHINERY for...

COATING

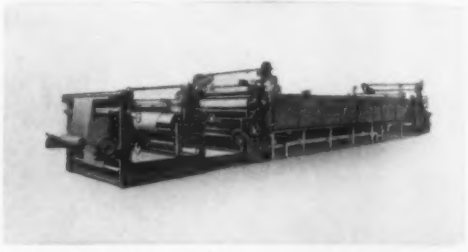
. . . paper, fabric, foil, film, with Saran, Diofan, polyethylene, glue, adhesive, PVC, resin, melamine, bitumen, wax.



Universal Coating and Impregnating Machine 4900/1

LAMINATING

. . . two or more webs of paper, board, fabric, aluminum, film, foils, etc., by means of glue, silicate, varnish, bitumen, wax.



PVC Coating Machine 6084/1

CASTING

. . . nitro, acetate, triacetate film and foils.

PRINTING

. . . coated fabric, oil cloth, PVC film, aluminum foil, decorative and wrapping paper, etc.

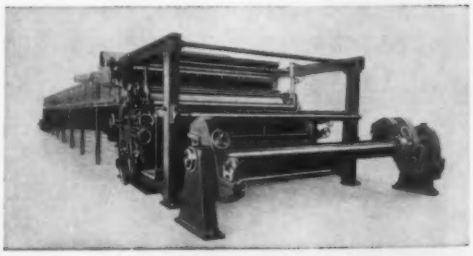


Film Casting Machine, band type 3281/1

IMPREGNATING

. . . paper, fabric, etc., with latex, phenolic, melamine, bitumen, oil, PVC.

. . . making photographic paper and film, abrasive paper and emery cloth, artificial leather, adhesive tapes, etc.



Varnishing and Impregnating Machine, up to 3500 mm working width 4070/1

HOFMANN & SCHWABE K. G.

KREFELD (WEST GERMANY)

Agents for machinery for photographic paper and film:
Messrs. Alfa, American Corp.,
303 West 42 Street, New York 36, N.Y., U.S.A.

Agents for any other machinery of our manufacturing program:
Messrs. Comac, Converters Machine Co.,
22 W. Putnam Avenue, Greenwich, Conn., U.S.A.

NOW--The New **AUTOMITE®**

pat. pending

Solves the short run compression molding problem

THE A50-B

AUTOMOLD

50 tons at 100 lbs. air pressure
60 tons at 120 lbs. air pressure

lowest priced high-speed fully automatic compression molding machine



FULLY AUTOMATIC, lowest cost, because of simplicity of design.

ECONOMICAL OPERATION and maintenance — uses existing air supply; simple electrical circuits; compact molds.

QUICK INSTALLATION — just connect to air supply and electrical power.

SIMPLE CHANGE-OVER — setting up molds in less than two hours.

FOR PRODUCTS made of thermosetting materials, including alkyds—

Appliance Parts,

Automobile Accessories,

Electrical, Electronic and Aircraft Components, etc.

Designed by Molders for Molders



Model A-10
self contained

–produces up to 30,000 pieces monthly from single cavity mold

–operates from available air supply 10 tons pressure at 80 psi. (air to oil)

–fully automatic... semi-automatic... or manual

–quick mold changes

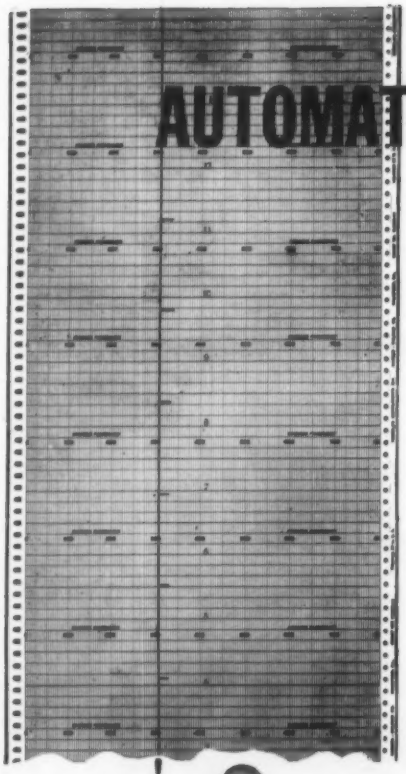
–utilizes existing cores and cavities

–lowest operating cost

Write for brochure and prices to...

AUTOMATIC MOLDING MACHINE COMPANY

3219 Exposition Place • Los Angeles 18, California



AUTOMATIC *Temperature Control*

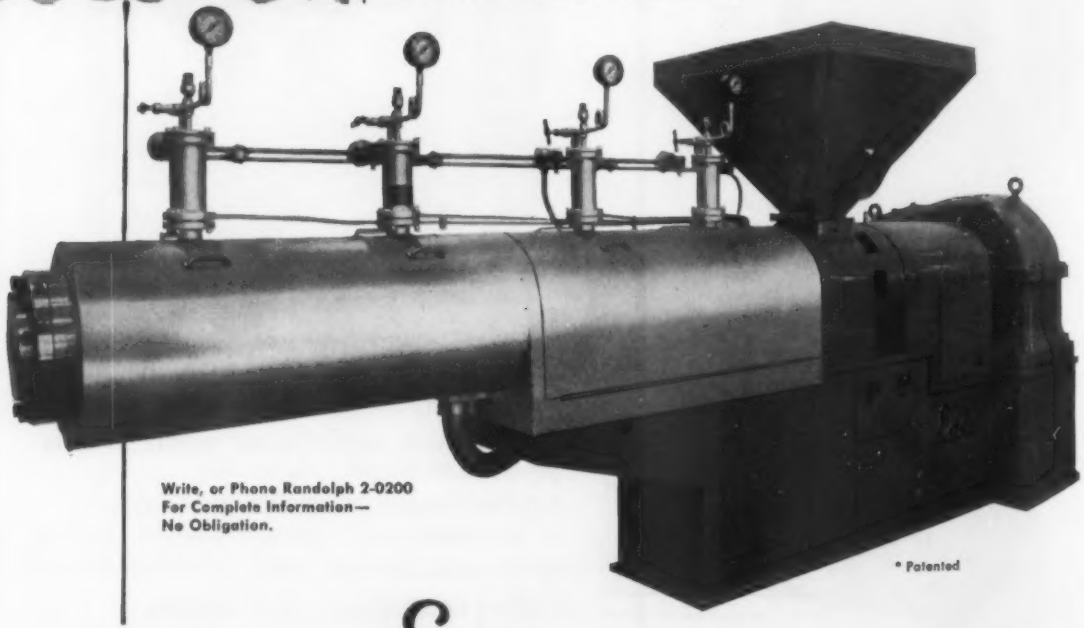
CLOSE TOLERANCE EXTRUSIONS... EASIER... FASTER... WITH THE EGAN EXTRUDER AND "WILLERT TEMPERATURE CONTROL SYSTEM"*

This revolutionary Egan combination automatically puts an end to the problems of heat control and quick cooling in the extruder cylinder... Simply pre-set the temperature and the "Willert Temperature Control System" takes over, providing completely automatic instrumentation.

NO MOVING PARTS
NO PUMPS, BLOWERS, COMPRESSORS
NO MANUALLY OPERATED VALVES OR SWITCHES

Available in full range of extruder sizes—2" through 8"

The strip chart reproduced at left shows actual material temperatures recorded during a typical day-long production run. Readings were obtained by inserting a thermocouple in the plastic melt at the output end of the extruder.



Write, or Phone Randolph 2-0200
For Complete Information—
No Obligation.

* Patented

FRANK W. *Egan* AND COMPANY

SOMERVILLE, NEW JERSEY

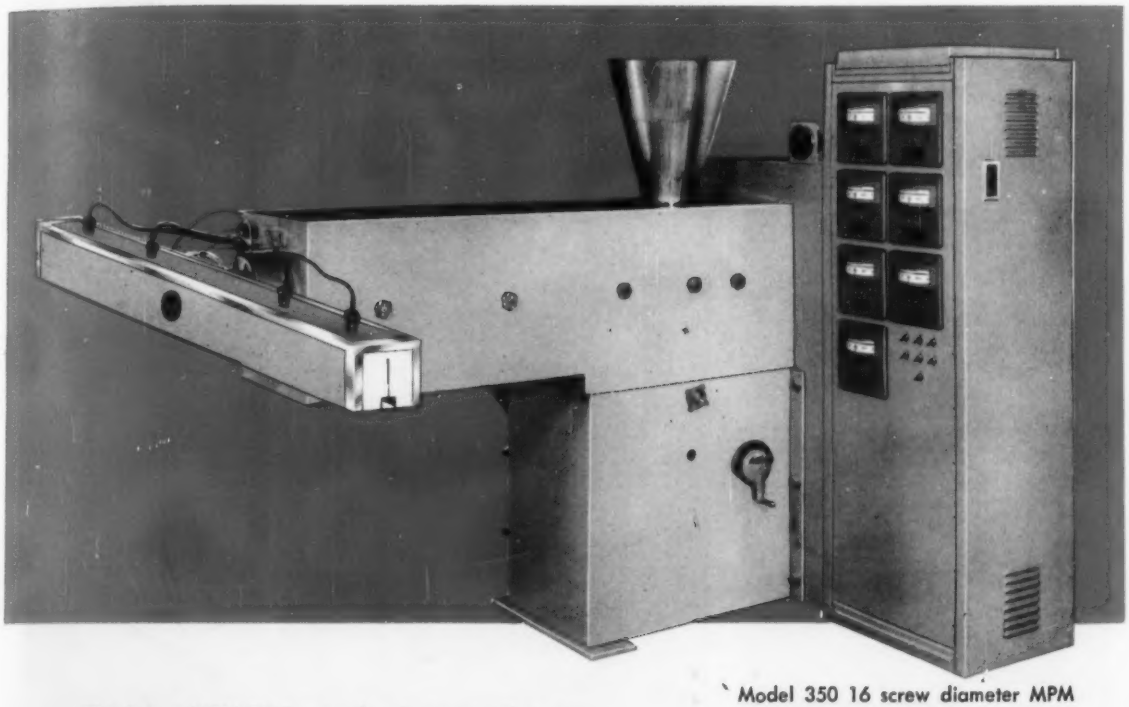
Manufacturers of plastics processing equipment

Cable Address: "EGANCO"—SOMERVILLE NJER

REPRESENTATIVES: MEXICO, D.F.—M.H. GOTTFRIED, AVENIDA 16 DE SEPTIEMBRE, NO. 10. JAPAN—CHUGAI BOYEKI CO., TOKYO. **LICENSEE:** GREAT BRITAIN — BONE BROS. LTD., WEMBLEY, MIDDLESEX.

WE *Challenge* COMPARISON!

MATCHED UNITS PROVIDE CLEARER, ACCURATE GAUGE, EXTRA WIDE FILM WITH MAXIMUM OUTPUT.



Model 350 16 screw diameter MPM Extruder with flat film die

This latest MPM 3½" extruder, incorporating new bearing assembly, with matching flat film die and takeup, is the most advanced and efficient unit of its kind available to the industry. Film can be produced with tolerances as close as .0001" across a sheet .00125" thick. In actual verified production, film up to 58" wide has been produced at the rate of over 200 feet per minute. The unique die design makes it possible, with extra capacity MPM extruders and takeups, to produce sheet up to 100" wide.

More, better, efficient production is the reason why MPM equipment is so widely used.

mpm

modern plastic machinery corp.

Manufacturers and Designers of

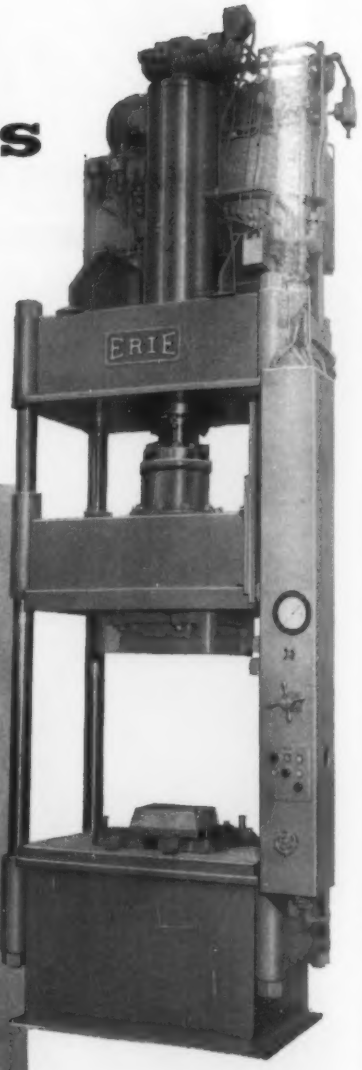
THE MOST ADVANCED PLASTIC PROCESSING EQUIPMENT

15 Union St., Lodi, N. J., U. S. A. • Cable Address: MODPLASEX

IN USE IN THE UNITED STATES AND THROUGHOUT THE WORLD

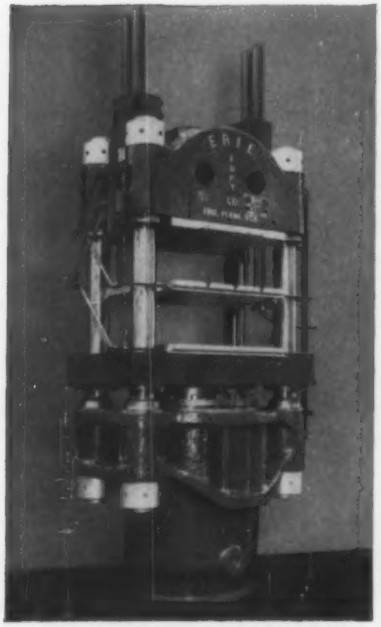
West Coast Representative: 8510 Warner Drive, Culver City, Calif.

ERIE PRECISION HYDRAULIC PRESSES



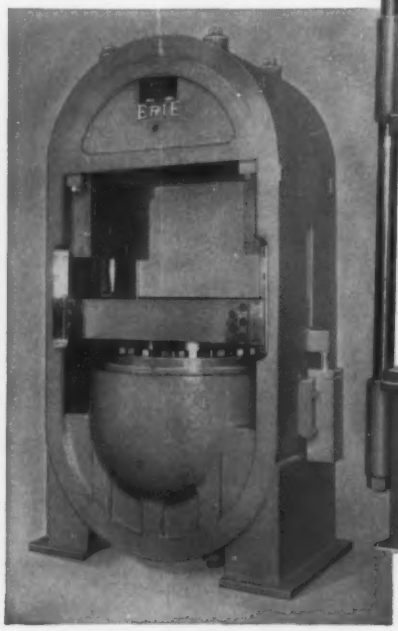
FIBERGLASS

100-TON self-contained press for molding fiberglass-reinforced plastics. Tonnage can be varied by hand valve on control panel. Approach, pressing, stripping and return speeds, as well as stroke lengths, are variable. Electric timer for automatic cure cycles. Up-acting or down-acting ram optional.



COMPRESSION MOLDING

A real work horse for the mechanical goods shop. This press, 800 ton model pictured, is available in many tonnages and platen sizes. Pushbacks optional. This machine can be arranged for automatic or single cycle operation and is available self-contained.



MINIMUM DEFLECTION

1500-TON loop-type press is *practically deflection free*, providing parallelism within .002", a result of low stress throughout. This machine is available with control and pumping unit, and can be arranged for automatic or single cycle operation.

Erie Foundry Company's vast and varied experience in designing and building hydraulic presses is yours for the asking. Our sales engineers are at your disposal. Write

ERIE

ERIE FOUNDRY CO. ERIE, PA.

SINCE 1895, THE GREATEST NAME IN HYDRAULIC PRESSES

Van Dorn



MODEL H-250 PRESS 2½ OZ.

is FAST!

Up to 1200 cycles per hour (dry run)

AUTOMATIC!

One operator can run 3 or more presses, for greater flexibility, and lower labor costs. Selective control permits semi-automatic operation.

EASILY OPERATED!

by semi-skilled help. With simple, handy controls, job can be set up in 20 minutes.

VERSATILE!

The sketches list only a few of the many thermoplastics molded on Van Dorns.

Made at Low Cost on VAN DORNS



Polystyrene Containers — over 720 per hour



Vinyl Cord Sets — over 2000 per hour

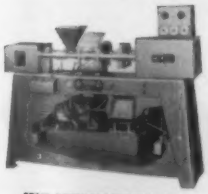


Polyethylene Closures — over 9000 per hour



Nylon Coil Forms — over 2000 per hour

Remember, For the Price of One Large Press, You Can Own a BATTERY of VAN DORNS!



SEMI-AUTOMATIC PRESS 2-oz. capacity.



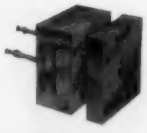
POWER OPERATED, LEVER CONTROLLED PRESSES 2-oz. and 1-oz. models.

WRITE FOR complete data on model H-250 and other equipment shown.

FINANCING AVAILABLE



PLASTIC GRINDER Grinds up rejects, waste, etc., for re-use.



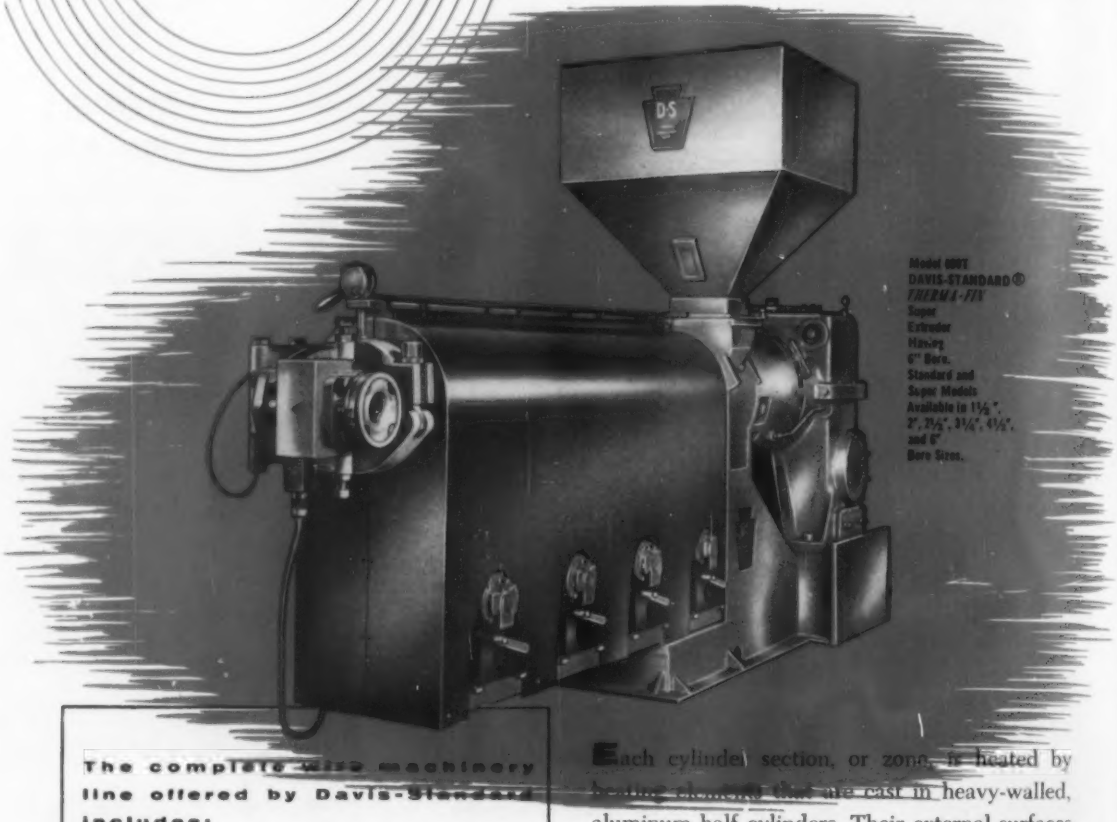
MOLD BASES Available from stock.

THE VAN DORN IRON WORKS CO., 2685 EAST 79th ST. • CLEVELAND 4, OHIO

THERMA-FIN EXTRUDERS*

for High Quality Extrusion of Thermoplastics

Since the development of the DAVIS-STANDARD® *THERMA-FIN* temperature control system, field reports from users have repeatedly remarked about the excellent temperature control maintained in these extruders.



Model 60VT DAVIS-STANDARD® *THERMA-FIN* Super Extruder Has 2½" 6" Bore. Standard and Super Models Available in 1½", 2", 2½", 3½", 4½", and 6" Bore Sizes.

The complete wire machinery line offered by Davis-Standard includes:

*THERMA-FIN Thermoplastic Extruders**

Rubber Extruders	*Steam and Water Seals*
Self-Braking Pay-offs	*Continuous Take-Ups*
Drag Capstans	*Pulling Capstans*
Splice Boxes	*Dancer Control Columns*
Vulcanizing Tubes	*Wire Measuring Machines*

Each cylinder section, or zone, is heated by heating elements that are cast in heavy-walled, aluminum half cylinders. Their external surfaces are finned to provide a large heat transfer area, and each section is individually cooled by a blower located below it. Baffles are located between sections so that the temperature of each section can be adjusted independently.

*U. S. Patents Pending

D-S MYSTIC CONNECTICUT U.S.A.

DAVIS-STANDARD

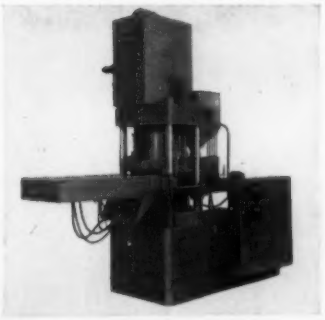
Division of FRANKLIN RESEARCH CORPORATION

14 WATER STREET, MYSTIC, CONNECTICUT

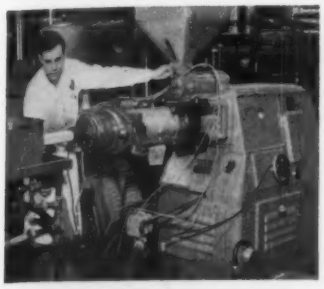
IN EUROPE AND THE STERLING AREA, CONTACT FINNEY PRESSES LTD., BIRMINGHAM, ENGLAND

The Complete line of equipment for Injection, Compression and Transfer Molding, Extrusion, Preforming, and Vacuum Metallizing

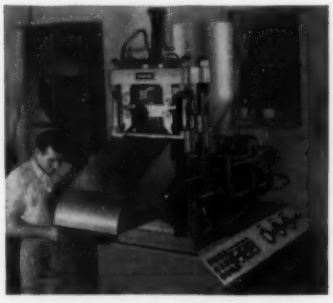
STOKES



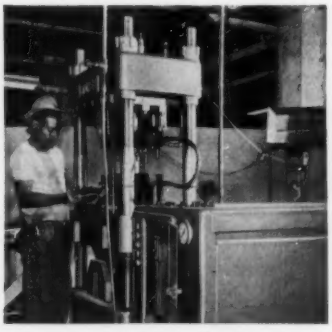
Stokes Model 741 fully automatic compression molding presses (125 ton unit shown here) provide highest attainable molding economy plus precision and flexibility. Available in 50, 75, 125 and 200 ton models. Other Stokes automatic presses include Model 800 in 15 and 25 ton capacities, Model 725 in 25 ton capacity and Model 252 closure presses in 50 and 150 ton capacities. Write for detailed catalogs 200, 513, 201 and 521.



A Stokes-Windsor Extruder making rigid PVC pipe at Firestone Plastics Company, Pottstown, Pa. It is also used for blending, compounding and other development of Firestone's Exon resins. Stokes-Windsor Extruders are available in capacities of 65, 120 and 250 pounds per hour nominal capacity. Widely used for making tubes, tapes, sheet, belting, channels, molding and pipe; also for compounding, coloring and pelletizing for molding or re-extrusion. Further details in Catalogs No. 525, 550.



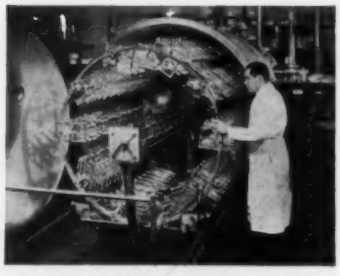
The Stokes Model 701 . . . the 2 ounce *truly* automatic injection molding machine molds, de-gates, ejects and sorts automatically . . . all without operator attention. Positive nozzle shut-off eliminates "drooling", permits full-pressure prepacking of injection cylinder for uniform plasticizing. Standard features include positive ejection, fast 3½ second dry cycle, simplified die set up. Stokes fully automatic injection molding machines are available in 2 to 6 ounce capacities. Write for Bulletin 565.



A modern and greatly improved version of the semi-automatic toggle press which we have been offering for many years. Model 731 is available in capacities of 50 and 150 tons. Ideal for resistor and condenser cores and similar parts. The toggle-type closing gives high initial speed, slow closing, freedom from distortion of inserts. Send for Catalogs No. 526 and 516.



Stokes Preform presses (Model 294 shown above) are available in 4 single-punch and 8 rotary sizes, and one hydraulic. Preforms are made in the range from small button sizes to those as much as 10 pounds in weight. Full details in Catalog No. 509.



This 72-inch Stokes Vacuum Metallizer processes as many as 100 loads per day of toys at Ideal Toy Corp., Hollis, N. Y. Gives brilliant, long-wearing finish in many metallic colors at minimum cost. On metal parts no buffing or polishing is required. Opacity of coating permits use of scrap plastic. Other models of 24-, 36- and 48-inch diameter. Send for detailed and generously illustrated Catalog No. 780.



Two of Stokes Model 727 semi-automatic transfer presses of 200-ton capacity at Kuhn & Jacobs Molding & Tool Company, Trenton, N. J. Top or bottom plunger; capacities 50, 100 and 300 tons. Without the transfer mechanism, this is Model 726, a compression molding press of the same capacities. For more detailed information send for Catalog No. 240.

STOKES

F. J. STOKES CORPORATION

5500 Tabor Road, Philadelphia 20, Pa.

ATLANTA • CHICAGO • CLEVELAND • DAYTON • PASADENA, CALIF. • PORTLAND, CONN. • UNION, N.J.

F. J. STOKES COMPANY OF CANADA, LTD.: TORONTO • MONTREAL

Machinery and Equipment

IN THIS SECTION

Instrumentation 890
For Injection Molding 893
For Compression and Transfer Molding 896
For Extrusion 898
For Laminating 901
For Coating 903
For Calendering 905
For Mold Making 907
For Compounding and Coloring 912
For Preforming 918
For Heat-Sealing 924
For Reinforced Plastics 925

As a guide to the year's activities on the part of machinery and equipment suppliers in making available new, more improved units for various plastics processing techniques, Recent Developments in each field will be reviewed in this section. All items listed have been excerpted from the New Machinery and Equipment section of MODERN PLASTICS, Oct. 1956 through July 1957 issues. Detailed information can be obtained from these issues.

INSTRUMENTATION

BY ROBERT BANCROFT*

The instrumentation of plastics processing operations has come to mean more than merely the installation of simple measuring instruments to indicate the values of such process variables as time, temperature, pressure, viscosity, and others. It includes control devices, frequently coupled with such instruments, to sense process deviations from preset control points and to make the necessary adjustments in the process to maintain operating conditions at established levels.

By holding process variables within closer limits than is possible by manual control and at far less cost, process control equipment is playing an ever-increasingly more important role in insuring optimum functioning of plastics fabricating equipment.

Compression molding

Three separate control systems are involved in compression molding of plastics: 1) control of the hydraulic system which actuates the prime mover; 2) temperature control of the platen to which the mold sections are attached; and 3) regulation of an auxiliary air supply.

The hydraulic power supply for the press normally consists of a high-pressure pump feeding a surge tank which acts as the high-pressure source for the press. The pump is usually left running continuously, and a pressure-loaded, self-operating-type pressure regulator, installed on a pump by-pass, is employed to maintain the desired constant pressure in the high-pressure system. An electrical overload limit switch, on the power supply to the pump motor drive, and a spring-loaded, high-pressure safety relief valve on the surge tank are control devices for protection of the equipment. Cycle timers controlling solenoid valves in the hydraulic system provide for automatic operation of the sequential steps in the molding process.

The mold temperature may be

* Senior plastics engineer, Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.

Recent Developments were prepared by the editors.

ntrolled in various ways, depending upon the type of heating system selected. Where electrical resistance heaters are used to heat the platen and/or mold, a simple bi-metal thermostat is often used for on-off control. When the platens and/or mold are cored, condensing steam may be employed as the heating media with a simple spring-loaded pressure regulator to control the steam temperature. In cases involving hot or cold water systems, a self-acting control valve with a vapor or liquid expansion bulb immersed in the water line frequently provides the desired control action.

The auxiliary air supply needed for cleaning the mold cavity of flash, lubricant spraying, ejection of molded parts, etc., at the end of each cycle is usually drawn from a central "house" system. In general, this system is comprised of an air compressor directly connected to a surge tank which acts as a reservoir to feed the system. A dual pressure limit switch usually serves to control the pressure in the surge tank through on-off control of the electric power supply to the compressor. Simple spring-loaded, self-operating pressure regulators are used at each station in the house system to supply air at the desired pressure; a spring-loaded pressure relief safety valve is also installed on the surge tank for protection of the system.

Transfer molding

The control equipment used in conjunction with transfer molding is very similar, in most respects, to that employed in compression molding. Additional control equipment is needed to handle a second complete hydraulic system[1], preheating of preformed mold charges, and other ramifications arising in processing different types of materials.

In transfer molding operations, one hydraulic system serves to close the press and hold the mold in a clamped position while a second hydraulic system is commonly used to provide the force for driving the transfer ram.[1] Although the individual control devices used are much the same as those in the hydraulic systems for compression molding, a bit more complicated arrangement of pressure regulators and valving is necessitated to provide the system with the flexibility desired in volumetric capacity and pressure. To rapidly close the press, high volumetric capacity at low pressure is used. As the press nears the closed position, a cam-actuated limit switch energizes a multiport solenoid valve which switches from the regulated low-pressure piping circuit to one at high pressure and low capacity to complete the clamping of the mold. Similarly, in driving the transfer ram, a high volumetric capacity at low pressure is initially desired with the ability to switch to a low capacity, high pressure, as the completion of the transfer is neared. An accumulator tank with a pressure-regulated pneumatic inner bladder is commonly used to augment the pump capacity at low pressure; for high-pressure delivery, the pump is directly connected to the press cylinder. A spring-loaded, self-operating pressure regulator on the house air line serves to

[1] Except for the older three platen presses with floating transfer pots, two or more controlled hydraulic systems are required for transfer molding operations.

RECENT DEVELOPMENTS

The Jordan Dancetrol provides automatic tension control from a few ounces up to several hundred pounds in the winding of paper, plastic webs, and tapes. It holds constant web velocity up to several hundred ft./min., is readily adapted to dancer rolls or pivot arms on existing machines, and may easily be incorporated as part of a new machine. *The Jordan Co., 3235 W. Hampton Ave., Milwaukee 9, Wis.*

A new instrument for controlling quality of film is the Viking hole detector. The standard model tests nonconducting materials up to 25 mils thick and detects holes 15 mils in diameter and larger at speeds up to 1500 ft./minute. With a 2- or 3-position recorder, the holes are not only recorded and counted, but located. *Viking Instruments, Inc., East Haddam, Conn.*

The E364 Robotron Control is a completely packaged unit that will automatically close a hydraulic press, freeze the mold at the right time, relieve gases by "bumping" at intervals, etc. Some advantages are: cycles may be reset in a few seconds, the operating pushbuttons are located on the case, and the solenoid-operated air valve is within the case. All relays are of the plug-in type for easy checking and servicing, and are completely enclosed for safety. *Emmett Machine and Mfg. Inc., 445 E. Turkeyfoot Lake Rd., Akron 19, Ohio.*

A new producer has entered the beta-ray gage field with a line of five Atom-At gages: a transmission gage for paper, foils, plastic films, etc.; a backscatter gage for coatings accessible from one side only; a differential gage for coated films; a multi-head gage for wide webs of coated films; and a transverse profile portable gage that measures thickness across the whole width of a sheet. *Nuclear Corp. of America, Inc., Empire State Building, New York 1, N. Y.*

Designed for use in printing, coating, tubing and rerolling, slitting and punching, tentering, intersheeting, and manifolding, the Linear Edgetrol photoelectric edge guidance system controls edge registration and web position of opaque materials, porous materials (lace, gauze, netting, nonwoven fabrics), single thickness film (polyethylene, vinyl, cellophane), and laminates. Edgetrol systems are available in three integrated forms for use with present web control equipment as well as in new types of applications. *Intercontinental Dynamics Corp., 170 Coolidge Ave., Englewood, N.J.*

maintain the back pressure in the accumulator tank. Electrical cycle timers working through relay circuits control multiport solenoid valves in each hydraulic system to carry out the press cycle of operations automatically.

Preheating of preformed mold charges is commonly accomplished in dielectric preheaters at each press with cycle timers acting to control the power supply to each preheat furnace.

Molding jobs requiring more critical control of temperatures and/or pressures during the molding operation are handled by proportional-type controllers, often also including a continuous record chart of the controlled variable plotted against time.[2] The control means or actuator may be either a pneumatic or electric motor-driven valve on a condensing steam or controlled water system supply line. Where electrical heating is involved, the motor drive operates a slide-wire rheostat to control the electric power input. In either case, cycle timers are usually used.

Injection molding

Injection molding, like transfer molding, commonly requires two or more controlled hydraulic systems plus auxiliary control systems for metering the charge, preheating the charge prior to injection, maintaining the mold sections at optimum temperatures, providing a regulated house air supply, and for controlling various special ramifications of the process such as automatic lubrication.[3]

In injection molding processes, a relatively low-pressure hydraulic system serves to close and clamp the mold while a high-pressure system is employed for driving the injection ram. As in compression molding, it is desirable for both hydraulic systems to provide flexibility in delivery pressure and volumetric capacity. The types of control equipment used in the hydraulic systems for injection molding and transfer molding are essentially the same.

The charge stock fed to the heating section of the press is metered either volumetrically or gravimetrically. Where volumetric metering is used, a cam mounted on the injector ram drives a variable stroke metering plunger. In gravimetric metering, the cam actuates a limit switch which triggers a dump solenoid when the molding machine is ready to receive the charge from a weigh bucket. An electrical time delay relay controls the interval during which the dump solenoid stays energized at the beginning of the injector ram stroke.

Encasing the cylinder of the injector ram is a multiple-zone preheater designed to melt and heat the charge to the optimum temperature and/or viscosity condition for injection molding. In common practice, separate electrical resistance heaters supply the heat for each zone with variations of on-off control through thermocouple-actuated millivoltmeter limit controls or pyrometers functioning on the principle of timed proportioning of electrical pulses.

Separate cooling systems are commonly used for maintaining optimum temperatures in each section of the mold.

A typical installation would consist of a centrifugal circulating pump drawing coolant from a controlled temperature reservoir or sump and feeding it to the manifold supplying the mold. The flow is controlled by vapor expansion bulb, mercury switch-type thermostats actuating solenoid valves on the supply manifold. The temperature of the coolant in the sump tank is regulated by additional vapor bulb-mercury switch thermostats controlling on-off, immersion-type, electrical resistance heater elements in the sump or actuating solenoid valves on cold water coils in the sump. A spring-loaded back pressure regulator mounted in the pump discharge manifold serves to maintain a constant supply pressure to the mold. An electrical overload switch is used to protect the pump motor drive.

A controlled house air supply is needed to supply compressed air for dislodging parts stuck in molds, cleaning molds of flash, etc. This control system was outlined above in the discussion of instrumentation for compression molding.

Special control systems have been devised to meet particular needs of various sorts. An interesting example is a cycle timer-controlled, automatic lubricating device[3] that provides a preset amount of lubricant directed at given portions of the mold after every set number of operational cycles. Cycle timers, working through relay circuits, actuate solenoid valves to achieve this function.

Extrusion

The extrusion process consists of two major steps: 1) the extrusion operation proper and 2) final processing of the extruded product. Variables to be considered in controlling the first step are: a) the operating speed of the screw; b) thermal gradient along the cylinder; c) back pressure in the screw cylinder, and d) feed temperature at the die head. Control of the final processing depends upon the nature of the extruded product. With so many diverse forms of extruded products, no attempt is being made in this general discussion to cover the many special control problems involved.

Optimum control of the extrusion operation presents some knotty problems. The inherent nature of the charge stock serves to confine many parameters, of course. The design of the screw, a subject of much controversy, further defines the operating parameters.

The charge is preheated to the desired state for extrusion by frictional heat as well as externally applied heat. While much of the heating is due to mechanical friction, it is probably most common to set a fixed rate of speed for the screw for each individual extrusion operation, and control the temperature gradient of the charge through external cooling or heating, as the need may be. Control of the screw speed is commonly accomplished by means of a mechanical variable-speed drive attached to a gear-head motor. The motor is pro-

[2] "Molding Plastic Tips," C. H. Miller, *Instrumentation*, Volume 7, Number 4, 3rd Quarter 1954, pp. 17-19.
[3] The device described was designed and put into use by methods engineers in Minneapolis-Honeywell's Plastic Molding Department.

tected against overload by an overload limit switch on the power supply line.

The large changes of viscosity and frictional characteristics with temperature, inherent in thermoplastics, necessitate close temperature control for extrusion operations. Accordingly extrusion machines are usually designed with multiple-zone cylinder heaters, the screw chamber walls being cored and/or jacketed. Electrical heaters are commonly used to supply heat while water or air serve as cooling media. Thermocouple-actuated multivoltmeter limit controls or proportioned pulse-type pyrometers, as previously mentioned in the discussion of controls used in injection molding, are commonly used for an on-off control of the electric power supply and to actuate solenoid valves on water or air cooling lines. While heat is normally supplied in the initial preheat zones to melt the charge, in many cases it is necessary to remove excess heat generated by friction in some zones, particularly if the machine is being operated at a high output rate. Similar controls maintain the feed temperature at the die head. Back pressure in the screw cylinder is determined by the design of the breaker plate and screens mounted at the discharge end of the chamber.

Summary

Control equipment is being employed in ever-increasing amounts to insure optimum results from plastics fabricating processes. At the present stage of development, the majority of the operations are but semi-automatic at best. With relatively broad tolerances allowed for many of the controlled process variables, comparatively simple control equipment is capable of providing the degree of control required. A number of ingenious control circuits have been contrived using these simple control elements to carry out sequential timed control functions very satisfactorily. Where more critical control of such key variables as temperature and pressure are involved, the more sensitive proportional-type controllers have been advantageously employed, often including recording of controlled variables.

EQUIPMENT FOR INJECTION MOLDING

BY ROLF PELIKAN*

An injection molding machine basically consists of the following component parts:

1) A steel frame or structure on which all parts of the machine are mounted, as listed below.

2) A hydraulic system consisting of motor-driven pumps, in which a hydraulic fluid, usually oil, is subjected to high pressure. This fluid, controlled by directional, pressure-reducing, unloading, and pilot valves, makes movement of parts possible.

3) Two hydraulic cylinders, complete with pistons and rods or rams. One is called the injection cylinder, the other the clamping cylinder. The pistons and rams of both these cylinders are advanced and retracted by the fluid pressure generated.

4) A heating cylinder, in which cold feed pellets are heated until they melt. The injection ram forces cold material into the heating cylinder which in turn forces the previously plasticated melt through the orifice into the mold.

5) Two thick steel plates, called mold or die platens, to which the two halves of the injection mold are clamped. One of these, the stationary platen, carries the so-called cavity half of the mold. To the other, called the movable die-platen, is clamped the core or ejector half of the mold. Both platens are mounted on closely aligned tie-bars, or on ways which are machined to close tolerance. The movable platen is set in motion by the clamping ram, either connected to it directly or by means of a system of links and toggles. Opening and closing is done by either retracting or advancing the clamp ram.

6) An electric system, consisting of limit switches, timers, and solenoids is needed to control time and sequence of the various operations of the machine. Electric heating elements, controlled by the "off and on" type pyrometers or the more accurate proportioning-type pyrometers, furnish the necessary heat for the proper functioning of the heating cylinder.

In addition to these basic component parts, various pieces of auxiliary equipment are needed to give the molder necessary flexibility and to enable him to cut costs by: a) reducing cycle time, b) eliminating or decreasing high cost of direct or indirect labor, and c) saving of material consumption. Time, labor, and material are the three main factors that make up total cost. Auxiliary equipment, used in conjunction with new molding techniques and continuous refinements in the design of modern molding machines have contributed greatly to lowered manufacturing cost. This is of the utmost importance to the molder in this highly competitive market.

Devices, techniques, and machine improvements can therefore be categorized with a view as to which of the three main cost factors they influence and reduce.

Time-saving devices

With operating costs at an all-time high, time-saving devices are always regarded with the greatest interest. Builders of molding machines have recognized this fact and have tried to improve performance and reduce cycle time of their machines. Faster ram speeds, in clamping as well as injection cylinders, have greatly contributed to increased output in shorter time.

Cycle time can also be cut by shortening and adjusting the ram travel on the die opening stroke, not only on the so-called all-hydraulic models but also on the link-type machines. Prepositioning of the injection ram (plunger advance) enables the molder to save valuable seconds on every injection stroke. Plunger advance can now be found on practically every modern injection machine. Many molding machines now also carry a "material prepacking de-

*Equipment Engineer, Ideal Toy Co., 184-10 Jamaica Ave., Hollis 7, N. Y.

Recent Developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

Several Formatons have been added to a line of injection molding machines. (Formatons are machines using a vertical clamp to allow the molded products to drop off ejector pins or stripper rings; removal of product is accomplished with an air blast which carries the parts out of the mold and into a chute that has been attached to the rear of the machine.) Formaton-2 Model A has a capacity of 2 oz./shot. Formaton-3 Model A is a 3-oz. version of the Formaton-2. The Formaton-C combination automatic injection machine incorporates features of the Formaton-A 3-oz. and -F 4-oz. machines. *Guy P. Harvey & Son Corp., Leominster, Mass.*

The Lester "package maker" is now being offered in four different filling speeds. The L-2-4-oz. standard model can fill at the rate of 7.8 cu.in./sec. at a shot pressure of 20,000 p.s.i. *Lester-Phoenix, Inc., Cleveland, Ohio.*

A new maker enters the injection machine field with a line of machines in the middle-capacity range. Models 400 and 800 feature a closed-circuit hydraulic system and a reversing Oilgear pump that eliminates hydraulic shock. They are equipped with a metering-type vibratory feeder, but will be furnished with Exact Weight scales if desired. Plug-in-type controls are grouped at eye level. *National Automatic Tool Co., Richmond, Ind.*

The Battenfeld line of injection machines (built in Germany) consists of 17 models ranging in shot capacity from ¼ to 52 ounces. Some of these machines are horizontal, some vertical, and up through the 16-oz. size either type can be had. Top injection pressure is 28,400 p.s.i. in all sizes above 5 oz., lower in the smaller models. *Molding Systems, Inc., Danielson, Conn.*

The Asmidar APM 21 is a hand-operated injection machine that is capable of molding all thermoplastics and is well-suited to making small numbers of test shots. Top injection pressure is 5700 p.s.i. *British Machine and Foundry Supplies, Ltd., 80 Shore Rd., Port Washington, N. Y.*

Thermastrip heating bands are said to be 40% more efficient than any other type. They consist of Calrod-type heating elements encased in aluminum, and feature full-circle heating, uniform heat distribution, and low loss to the surroundings. They are available in 1.5- and 2.5-in. widths, and in diameters from 4 to 12 inches. Larger bands can be made to order. *Thermal, Inc., 9400 Robinson Rd., Franklin Park, Ill.*

Featuring a radically different preplasticator mechanism, the Lewis Model 616-PP-12 is the first production machine used to mold the low-pressure linear-type polyethylenes. The new preplasticator, which was designed particularly for this 8-oz. machine, raises its shot capacity to 22 ounces. It has a nozzle shut-off valve that does away with the need for holding pressure on the ram after injection (unless the mold is to be packed). *Lewis Welding and Eng. Corp., 2300 St. Clair Ave., Cleveland 17, Ohio.*

Small injection press models 357 and 357A have been furnished with an auxiliary 5-g.p.m. pump that cuts their dry-cycle time to just over half that of the earlier models. The two machines are rated for 2.75 oz. of polystyrene per shot at pressures of 20,000 and 10,000 p.s.i. with dry-cycle times of 3.3 and 4.6 sec. respectively. *Clifton Hydraulic Press Co., 289 Allwood Rd., Clifton, N. J.*

The model 300 TL injection molding machine is a horizontal machine with a rated shot capacity of 12 oz. of polystyrene, with up to 16 oz. with prepacking. *Reed-Prentice Corp., Worcester 4, Mass.*

The Impco HAS-275 is an 8- to 10-oz. machine specifically designed for automatic molding of deep-draw parts requiring a long stroke. The stroke, adjustable to 14.2 in., can be reset without upsetting adjustments. *Improved Machinery Co., Nashua, N. H.*

In-line preplasticator for the Peco 30M injection machine which shoots up to 8 oz. of polystyrene, embodies a new principle of preplasticator design The preplasticator is coaxial with the heating cylinder, the nozzle of which acts as the plunger for the preplasticator. Injection pressures on the hot melt up to 9800 p.s.i. can be obtained. *Peco Machinery Sales, Ltd., 28 Victoria St., London, S.W.1, England.*

---

vice," which is a modified plunger advance system. This device enables the molder to pack more feed material into the heating cylinder by repeated advancing and retracting of the injection ram. The advance of the ram is controlled either by an electric timer or a limit switch, allowing the plunger to go just far enough to introduce more material into the cylinder without exerting so much pressure as to force material into the mold. Thus more material can be plasticated per cycle, enabling the molder to run larger than standard shots on his machine, and so uprate his machine capacity.

Most manufacturers of molding machines and equipment have recognized the fact that a machine will not be able to perform faster or better than the efficiency of the heating cylinder will permit. Advertised dry-cycle-time and actual operating performance under load are often quite different and it is found that the actual speed of operation and performance is to a great extent controlled by the efficiency of the heating cylinder, i.e., its capacity

to plasticate material fast enough to keep up with the modern fast-running injection, clamping, and ejection devices.

Many improved heating cylinder designs have been put on the market. Conventional, spreader-type cylinders are now designed with longer bodies, higher wattages are provided, and the internal design of the cylinders has been so changed that higher rates of heat transfers are obtained, thus speeding up the plasticating process.

Another great step forward in raising the capacity of the heating cylinder has been in the application of preplasticators. As the name implies, material is plasticated before it is needed. It is then conveyed to the injection cylinder by means of an extruder-type screw mechanism or by a reciprocating auxiliary plunger. It is obvious that in this method there is always enough melted material ready to be injected, as the preplasticating chamber is constantly being refilled throughout the cycle of the machine. Usually, the one retarding factor in this process results from the fact that most molded articles need a certain cooling time in the closed mold in order to solidify the material properly. Close attention has to be given to the design of molds scheduled to run in preplasticators, especially to the layout of water channels, so that maximum cooling can take place in the shortest possible time.

Besides these conventional heating cylinder models, a new type of cylinder, the "melt extraction" type, has been introduced. This cylinder has a perforated inner liner, in contact with the outer cylinder wall where the heat transfer takes place. As the material softens it is forced through the perforations of the inner liner and is channeled to and ejected through the nozzle into the mold. It is claimed that the melt extraction type cylinder gives more uniform melt temperatures and that it speeds up the plasticating process. Their design is complex, however, and they seem to serve best when they are designed for molding a particular plastic.

Special attention has been given in recent years to maintenance and mold setup problems, in order to keep "down-time" to a minimum.

Hydraulic manifolds are now widely used to provide compact, easily accessible hydraulic systems with most hydraulic valves in one central location. The use of manifolds, flexible hydraulic high-pressure hose, and lately, high-pressure swivel pipe fittings has eliminated many leaks which were due to vibration of rigid piping or caused by strains in piping due to faulty assembly. Flexible, high-pressure hose has in many instances replaced the hard-to-handle seamless steel tubing used in the past. The new, flexible hose assures leak-free operation and quick replacement in case of damage.

A feature which has helped greatly to cut down mold setup time is the auxiliary hydraulic cylinder used for quick, effortless nozzle setting. Old-style ratchet-type systems are being replaced by motor-driven gear systems, which facilitate the clamping setup of the link-type machine. The need for greater accessibility to mold clamp areas has been recognized and machine frames have been so laid out that molds can now be clamped with greater speed.

Another important time-saving factor is now in the making. The Injection Machine Division of the S.P.I. has set forth standards for the layout of knockout pins, platen bolt-hole patterns, and nozzle lineup rings which will make a great degree of interchangeability possible. The molder will be able, in the future, to switch molds from one machine model to the other without the added expense of making tool alterations. This is a very important step, as considerable time and money has often been spent in adapting a mold, designed to run in one type machine only, to fit another. This will be particularly welcome news to those molders who plan to have machines of different manufacture in their shops.

Material-saving devices

An important development in material savings in recent years has been the perfection of a new molding technique, based on a new mold design. This new design has brought about the process called "hot-runner molding." In this process, the material of sprues and runners is kept in plasticated state by means of heating elements which are controlled by sensitive instruments. This material is injected into the cavities through all-enclosed runner systems. The advantage of this technique is that less material is removed from the mold per cycle, since only the molded piece with its small center gate is removed, and sprues and runners remain in the mold. Scrap of runners and sprues is completely eliminated and degating has been greatly facilitated. In addition, it is reported that center gating, which in hot-runner molding is the conventional and accepted way of introducing material into the cavity, has greatly cut down reject figures due to shorts, strain, and flow marks. Another important advantage in the use of the hot-runner mold system is the fact that the melt temperature can be kept lower, in the safe range, thus avoiding brittleness and other defects in the finished article.

Weigh-feeders also save material, and even more important, they improve control of quality. A weigh-feeder is a sensitive balance which automatically weighs each charge of material before it enters into the cylinder. Automatic or manually operated compensating devices correct any variance of weight of the material fed, insuring trouble-free operation. Wall cross-sections of molded parts can be kept much more uniform throughout the production run of the mold, overpacking of molds is eliminated, and considerable material savings can be achieved. Recognizing this advantage, many machine manufacturers offer weigh-feeders as standard equipment with their machines.

Another method of flash prevention is a rather simple system of accurate microswitches so set that they will break an electric circuit as soon as the faces of the mold have separated a few thousandths of an inch, due to the pressure exerted by the in-

jected material. The breaking of that circuit de-energizes a solenoid-operated hydraulic valve which switches the injection stroke automatically to low pressure, thus preventing flashing of the mold.

Labor-saving devices

Devices designed to eliminate or decrease the high cost of direct or indirect labor, where this can be done safely, have been viewed with particular interest by the injection molder. Of these, automatic molding devices are the most widely used. Known for several years in the industry, these low-pressure-closing, recycle, automatic-ejection, and alarm systems have been improved and modified and are now standard equipment on many new molding machine models, especially from the 12-oz. class down.

The special feature of the low-pressure-closing system is the fact that full clamping force is applied only when the faces of the mold have met. The mold is closed under low pressure to prevent damage to cores and cavities in the event that a molded piece has not been ejected properly and is stuck in the face of the die.

Special emphasis has been put on the problem of shot removal from the mold. The original automatic molding systems were provided with air valves, either mechanically or electrically operated, which directed a combination of air streams into the mold at the moment of full ejection. These air streams blew the molded articles off the cores and ejector pins and directed the shot downward into a bin or pan located under the tiebars of the machine.

In recent years, new shot-removal systems have been developed in which shots are removed from the mold by sweeping devices or combs activated pneumatically or hydraulically. These systems give more positive assurance of complete shot removal than does an air blast. Combs or sweeping devices are so designed that they cover every part of the mold face and ejection system. It is often difficult to direct air streams so that they do not interfere with each other or cancel each other out and so neglect areas of the mold. It is of course necessary to protect molds and combs with a system of interlocking micro- or limit- switches which will prevent the mold from closing before the sweeping device has cleared the mold faces.

Another important labor-saving device is the small scrap grinder, set up next to the molding machine and run by the machine operator. This unit will regrind sprues, runners, and rejects on the spot, thus eliminating the need for expensive material handling and redrying. In the design of new models special emphasis was placed on rigid construction and easy accessibility to cutting knives for repair and cleaning purposes, so that down-time could be held to a minimum, and color and material changes could be made quickly.

A great deal of labor is expended on loading feed, as all raw material must be fed into the machine through a material hopper which is at a considerable distance from the floor. Much work has been done in developing automatic devices to raise material to the hopper. These automatic material loaders use compressed air on the Venturi principle, or work by means of small fans. In earlier models great difficulty was encountered in lifting reground materials or so-called fines. Clogging of tubes usually resulted. In the last couple of years improvements were made and design changes incorporated with the result that there are now several models of material lifters on the market which can be used universally on all materials. Another development in conjunction with equipment of this kind is the use of a combination regrinder and hopper loader which combines the features of the abovementioned devices and so reduces handling and transportation cost.

The most obvious over-all trend in the industry seems to be toward specialized equipment to meet the specific needs of molders. Machines with extra-long die-opening strokes for so-called deep draws, especially desired by the housewares molder, molding machines with vertical mold openings for the insert molder, and special nozzles with heat control devices and combination dehumidifier-preheaters for the nylon molder are but a few examples of specialized equipment now in use.

EQUIPMENT FOR COMPRESSION AND TRANSFER MOLDING

A compression press consists essentially of a ram in a cylinder or pot, the pot being tied to a resisting head member through strain or tie rods. A movable platen equipped with bushings, one for each strain rod, is mounted on the outside end of the ram. Thus, clamping action occurs between the top of this movable platen and the flat underside of the press head. The ram is usually hydraulically operated. There are a few mechanical toggle presses too, and a combination hydraulic-pneumatic press. Hydraulic power is delivered either by a central accumulator system or by separate pumps that can be adapted for each press.

Although many presses today are self-contained—that is, are equipped with all controls as well as their own pumps—there are many plants which operate with a central pressure system which supplies hydraulic power for the entire plant. These central systems require high-pressure pumps, low-pressure pumps, and also hydraulic pressure accumulators.

Three types of accumulators are in standard use. In one, the accumulator piston raises a heavy weight against gravity, and the weight is adjusted to give the desired hydraulic pressure. In another, the accumulator piston acts against a compressed air piston of much larger diameter, and the force exerted by the air produces the hydraulic pressure. In the third type, the water is pumped

Recent Developments were excerpted by the editors from Modern Plastics, Oct. 1956 through July 1957.

against a volume of compressed air; the compressed air is located in a tank.

The different types of compression presses are designated according to their method of control, that is, 1) hand-operated, 2) semi-automatic, and 3) fully automatic.

The designation hand-operated indicates that the motions of the press are actuated by manually controlled valves. Such a press may be used with what is known as a hand mold, so called because it is not permanently mounted in the press, but is removed from the press after the curing cycle has been completed, and dismantled on a convenient bench placed near the press.

After the part has been removed from the mold, molding compound and inserts, if required, are placed in the cavity of the mold, the force plug is placed in position in the mold, and the entire assembly is manually positioned on the lower platen.

The hand-operated press may also be used with the two halves of the mold permanently assembled on the platens of the press. In this case the mold may be equipped with knockout pins which are actuated by the motion of the press; or the mold may be of a simple design requiring only a blast of air to remove the part.

In a semi-automatic press, the mold is generally mounted permanently in the press, and the only difference between the operation of this type mold in a hand press and in a semi-automatic press is that in the latter case the operator starts the molding cycle by pressing a button or other control, and the complete cycle of mold closing, curing, and mold opening proceeds without further operator attention. The cycle, however, comes to a dead stop after the mold is open, and it is necessary for the operator to recycle the machine manually after the molding material has been loaded in the mold. All types of auxiliary equipment, such as knockout pins, side angle draw bars, etc., can be included in this semi-automatic cycle arrangement.

In the case of the fully automatic press, no operator attention is required. All functions of molding, from material loading right on down to the ejection of the part, are completely automatic.

Any one of these types of presses can be further considered as upward-acting, downward-acting, and angle presses. In the case of the upward-acting press, the hydraulic ram moves upward and the hydraulic cylinder or pot is mounted in the base of the press. In the second or downward-acting type, the pot is mounted on the head of the press,

RECENT DEVELOPMENTS

The Stokes Model 741 line of presses has been completely redesigned for greater speed, dependability, and safety. Available in ratings of 50, 75, 125, and 200 tons, the new presses are fast closing and fast pressing—closing times are only 2.9 sec. from feed to mold contact, while pressing speed is adjustable up to 27 in. per minute. The platen areas range from 28 by 16 to 38 by 22 in. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

The Models 150-22 and -33, with 75 tons capacity, are especially engineered for precise control of temperature and pressure. Platens are 14 by 14 in., the Model 22 having two, the 33 having three. Total daylight opening is 6 in., stroke is 6 in., ram diameter is 6.5 in. Closing speed is 50 in./min., and the ram returns (falls) under its own weight when pressure is released. Available temperature range is 150 to 550° F. with built-in electrical heating. *Atlas Hydraulics, Inc., 3576 Ruth St., Philadelphia 34, Pa.*

Designed to provide a wide range of experimental pressing conditions, a new PHI 300-ton press offers three high-pressure ranges: 0 to 10 tons, 0 to 60 tons, and 0 to 300 tons. Each range is provided with its own gage, so that any ram force from 1000 to 600,000 lb. can be maintained with high accuracy. Two built-in, dual-scale pyrometers indicate the temperatures of the heated platens. *Pasadena Hydraulics, Inc., 273 North Hill Ave., Pasadena, Calif.*

The Elmes 300-ton hydraulic compression press is especially designed for convenient use in pairs, two presses being run by a single operator. Available in right- and left-hand models, the press has a stroke of 18 in. and an operating pressure of 2640 p.s.i. The opening between platens is 44 in., and dies up to 36 by 30 in. can be accommodated. Operating speeds in in./min. are: advancing, 309; pressing, 15; and returning, 131. *American Steel Foundries, Elmes Engineering Div., 1150-B4 Tennessee Ave., Cincinnati 29, Ohio.*

The Model 400-150 press, said to be the first automatic 150-ton press, automatically performs such operations as feeding, degassing, ejection, and flash clean-out. It also features a wide range of closing speeds—from 6.1 to 355 in./minute. The loader makes it possible to feed as many as 40 cavities per cycle; several tubes may be directed to feed into a single cavity, or may be shut off completely, as desired. The number of cavities fed can be changed in a few minutes, so very little extra setup time is needed to adjust the feeder when molds are changed. The stroke of the press is 15 in., and its daylight opening is 30 inches. *Baker Brothers, Inc., P.O. Box 101-Station F, Toledo 10, Ohio.*

The Model 99-A fully automatic transfer molding press is particularly well-suited for getting into production quickly and at low cost, on low-quantity runs, and for economical molding of small parts. Air-operated, the press requires a ⅛- to ¾-hp. air supply at 80 p.s.i. Transfer pressure adjusts to 9000 p.s.i., while the clamping capacity is 15 tons. *Hull-Standard Corp., Abington, Pa.*

and the movable ram goes downward to clamp. The angle press is somewhat different in that it consists of either an upward- or downward-acting mold clamp, tied to a horizontal-acting hydraulic ram and cylinder assembly. This special type of press is used for certain molding jobs which require mold opening in more than one direction.

Press capacity

Certain specifications for compression presses are more important than others; for example, most compression presses are rated as having a capacity of "X" tons. For example, a 150-ton press will have a clamping pressure of 150 tons between its movable platen and the head of the press when operated at the specified hydraulic pressure. Because of the factor of safety which is designed into the various elements of most hydraulic presses, this pressure can be raised somewhat, thus increasing the tonnage. In the majority of cases, however, accumulator-operated presses are designed to operate at hydraulic pressures of 2000 to 2200 p.s.i. In the case of self-contained presses, the hydraulic pressure is controlled by the pumping equipment installed by the manufacturer. Presses are available in capacities from 5 to 3000 tons.

The platen area of a compression press indicates the maximum size mold which can be mounted in the press. In some cases, of course, molds somewhat longer or wider than the platen area can be operated in a press with a portion of the mold projecting outside of the platen area; however, this is not recommended. Because of the very high pressures used, the portions of the mold projecting outside of the platen might tend to bend slightly, causing excessive flash and poor cut-off.

The "daylight" opening refers to the maximum possible space obtainable between the inside of the head of the press and the movable platen.

Transfer molding and presses

A compression press can be simply converted to transfer molding. In this case, a second movable platen or bolster plate is mounted between the ram platen and the head. A transfer pot or chamber is mounted on the top of this movable bolster plate, and a fixed ram, the outside diameter of which is slightly smaller than the inside diameter of the pot, is mounted under the head of the press directly above the pot. A sprue bushing, which serves to deliver the material from the transfer pot to the mold, is designed so that it will go through the bolster plate and screw into the bottom of the transfer pot.

In this type of transfer molding, the mold clamp available depends upon the diameter of the transfer pot, since the only force available for both mold clamp and transferring is derived from the single hydraulic ram of the press.

A transfer press is essentially a compression press equipped with an additional or auxiliary hydraulic ram. The clamping ram of the press may be either upward- or downward-acting, with the transfer ram operating in a direction opposed to it. An angle press may be used for transfer molding, in which case the molding material may be transferred into the mold either by the vertical-acting ram or the horizontal-acting ram; the second ram acts to open, close, and clamp the mold.

The use of a two-ram or transfer press for this type of molding permits the use of more cavities in a mold than it is possible to use in a single-ram compression press converted to transfer molding. This condition is made possible since the total available clamping capacity of the press is entirely used for clamping, whereas in the case of the single-ram transfer method, a sizable portion of the clamp ram's tonnage is used for transfer pressure, and is thus lost to the clamp section. Although the two-ram-type press is used with the transfer setup, making use of a separate transfer pot, it is generally used with what is known as pressure-type transfer molds. This type of mold has the transfer pot built directly into one half of the mold. The diameter of this pot is slightly larger than the diameter of the transfer ram.

With the transfer ram in the withdrawn position, preforms of molding compounds are dropped into this hole, and the action of the transfer plunger causes the material to flow through the runners and gates into the cavities of the mold. With this design, no sprue is used, so that when the mold is open a complete shot includes not only the parts and runners, but also the cull disk.

Other equipment

There are two general types of preheaters used to precondition thermosetting compound before it is compression or transfer molded. One is the oven type, which gains its heat either from steam coils circulating hot air, or infra-red lamps. This type of preheater also doubles as a predryer.

The second type of preheater operates on the dielectric principle; that is, it makes use of the dielectric constant of preformed molding compound which causes the material to heat uniformly throughout its mass when it is used as the dielectric of a condenser. Standard high-frequency preheating equipment of this nature is available in varying capacities up to 15 kw., which size will raise the temperature of 12 lb. of thermosetting material from ambient temperature to 250° F. in one minute.

EQUIPMENT FOR EXTRUSION

BY ALBERT A. KAUFMAN* and FRANK R. NISSEL*

Today's improved extruder designs have been influenced to a decisive extent by the following four factors:

1) Extensive work has been done on the theory of plastics extrusion, and especially on extruder screw design. This has brought to an end a period of trial and error in the designing of equipment for extrusion.

2) Extrusion has developed broadly and entered fields not originally its target: namely, film and sheet extrusion, coating, and

* Prodex Corp., Fords, N. J.

References were prepared by the editors.

Recent Developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

laminating, as well as various processing phases connected with compounding.

3) Wide field experience has resulted in a more critical economic analysis of machine performance. More production per invested dollar, lower operating costs, easier start-ups, and less maintenance have become more important factors.

4) The increasing scarcity of skilled personnel for operation and maintenance has resulted in more fully automatic control features and better instrumentation.

Machine construction

Basically, the extrusion machine consists of a stationary cylinder within which a closely fitted screw is rotated. Some machines use two or more screws. Material is conveyed continuously from the feed opening to the die orifice. There are a great many variations in the manner of driving the screw, absorbing its thrust load, and mounting the machine components. The following is a brief review of the major designs.

Gear transmission

Since extruder screws usually turn at speeds lower than those of the motor drives, it is necessary to use a gear reducer. These are built in several forms:

a) *Herringbone:* The transmission loss of herringbone gears is only 2 to 4 percent. The units are very durable, but are the most costly type.

b) *Helical:* Efficiency is about the same as that of herringbone reducers, but there is an axial thrust on the shaft bearings. With properly designed bearings, helical gear transmissions are well-suited for extruding machine drives.

c) *Worm:* Transmission loss is 10 to 25% and there are heavy axial thrusts on the worm bearings. These units are popular because of their low cost, but this is offset by the higher cost of a larger motor and its increased cost of operation for the same output.

d) *Chain and sprocket:* The cost of this transmission is very low, but it is not generally considered to be suitable for extruder drives because of its irregular power transmission characteristics.

A versatile extruder transmission must be capable of delivering the full motor horsepower over a wide screw speed range, so that a variety of compounds and different shapes can be run at high efficiency. A 2:1 full-horsepower speed range is desirable. Since gear transmissions have load ratings directly proportional to their speed—i.e., the rating decreases with the machine speed—the gear reducer should have approximately twice the motor rating. Extruder trans-

RECENT DEVELOPMENTS

Designed to impart gloss and improve the physical characteristics of thermoplastic sheets, the sheet glazer is most conveniently used in conjunction with an extrusion train. The underside of the sheet is chilled as the sheet moves on liquid-cooled rollers while the top face is radiantly heated to the flow temperature. Over-all length is 50 inches. *Goulding Mfg. Co., 2929 River St., Saginaw, Mich.*

An auxiliary extruder with a screw 1.25 in. in diameter by 12 in. long is especially designed to provide a small sidestream of melt of a second color in an extrusion where the main stream is furnished by a bigger machine. Several such auxiliaries can be used to achieve many color effects. Such products as multicolor welting, belting, tubing, etc., are easily made. *Thermoplastic Processes, Inc., 1949 Valley Rd., Stirling, N. J.*

The Rolis line of extruders, ranging in size from 1.5 to 4.5 in. in diameter, are said to be designed for durability. The barrel is electrically heated and water cooled, for fast response, but oil-heated cylinders are available. The chrome-plated screw has an L/D ratio of 20:1 on the standard-length machine in each size class. *Rolis Inc., 1240 E. 14th St., Brooklyn 30, N. Y.*

The Foster-Wucher W700 consists of an extruder and a turntable containing multiple molds. The extruder drive is connected to the screw, through a magnetic clutch, which is engaged only when a mold is indexed to the nozzle. The extruder then fills the mold and is stopped, the turntable indexes the next mold, and the last-filled mold cools as it proceeds around the circuit. Since injection pressure is relatively low, molds can be made of cast aluminum or zinc alloy. Screw diameter is 4 in., length is 30 in., speed ranges from 140 to 280 r.p.m., drive horsepower is 13. Most of the plasticating is done by viscous working. *International Vulcanizing Corp., 104 Brookline Ave., Boston, 15, Mass.*

A new center-fed cross-head sheeting die is said to be suitable for extruding most thermoplastics. It consists of an adapter, the manifold, a restrictor bar, a "flow chamber" and one set of adjustable die lips. Wide-land lips are recommended for thicker gages, narrow-land lips for thinner gages. The die is available in slit lengths ranging from 26 in. to 54 in., with thickness adjustments ranging from 10 to 190 mils. It is fitted with Chromalox heaters. *Johnson Mfg. Co., 229 S. Main St., Chippewa Falls, Wis.*

The Series 700 multiple-knife cutters are designed primarily for cutting cold plastics extruded in rod form (spaghetti) at high linear rates. The throat entrance is approximately horizontal and the width may be 5.6, 9.6, 11.6, or 13.6 in., ±0.1 inch. The rotating element contains 24 cutting blades mounted in such a way that the cutting action resembles that of a reel-type lawn mower, i.e., one end of each blade reaches the fixed (or bed) knife before the other end does. This distributes the working load, reducing shock to blades, mountings, and transmission. *Taylor, Stiles & Co., Riegelsville, N. J.*

missions require a service factor of 1.25 (A.G.M.A.); therefore, a 40-hp. load requires a reducer rated at 50 hp.

Thrust bearings

The extruder screw exerts an axial pressure toward the feed end which is roughly equal to the melt pressure at the die, or about 2000 p.s.i. A heavy, perfectly aligned, and well-lubricated thrust bearing must be provided to absorb the load.

Feed section

The feed section is usually a sturdy part which supports much or all of the cylinder weight through a flange connection. The feed opening may be round or rectangular, and can be either centered above the screw or tangential. The opening should be large enough to avoid bridging of materials. Feed sections are generally jacketed for cooling to avoid adhesion of some polymers to the feed-opening throat.

Cylinder

The extrusion cylinder consists of a precisely machined steel tube or forging. For uniformity of temperature, it is best made of a single piece without flanges. A variety of internal surfaces have been used to provide good wear resistance toward the screw and compound. Nitriding, flame-hardening, and chrome plating have largely given way to Xaloy which has the best all-around properties for most materials.

The screw

The screw conveys the material forward from the feed opening to the die. The material is heated to a melt and compressed with the elimination of much air. The screw should provide a uniform and high output rate against the back pressure provided by the die.

Extruder screws usually have three working zones: 1) material pick-up and initial transport; 2) compression and heating to a state of fusion; 3) pumping at a constant rate toward the die (metering section).

Extruder screws have been the subject of extensive theoretical study, and much of the theory has been substantiated in production experience. Basically, the effective output rate of an extruder is equal to the drag flow minus the pressure back flow minus the leakage flow. The drag flow is the forward motion of material provided by the dragging action of the barrel on the melt in the helical channel of the screw. The back flow is the reverse flow of material within the screw channel caused by the back pressure of the die restriction. Leakage occurs between the barrel and the thread lands. It is usually negligible. Calculation of each of these three components of output permits the design of highly productive extruder screws.

A breaker plate, often used in an extruder between the cylinder and the die, serves to support screen packs which filter the compound and is thought to aid in homogenizing the material.

Length/diameter ratio

The effective length/diameter ratio (L/D) of an extruder is defined in the following terms:

L: Length of cylinder from front end of feed opening to front of cylinder.

D: Inside diameter of cylinder.

This ratio is of considerable practical importance since longer machines give higher outputs and better uniformity, with resulting closer tolerances in the extrudate. In the past few years the "standard" L/D ratio has increased almost twofold to about 20.

Temperature control

Plastics extrusion requires precise and quick-acting temperature control. Both heating and cooling are necessary at the present stage of technology. There are three basic temperature control systems.

1) *Electrical:* Here the cylinder is encased in tightly fitting electrical heating elements governed by automatic feedback controllers. Three-position temperature controllers permit fully automatic temperature control with air blowers or evaporative cooling. Water cooling by coils or jackets has been found undesirable.

2) *Fluid:* Here the cylinder is jacketed and a hot fluid is circulated. Water, oil, Dowtherm, and Ucon are commonly used. The system is very effective, but the initial and maintenance costs are higher than those of electrical systems. Additional heat exchangers provide cooling.

3) *Steam:* Here the cylinder is surrounded by a steam jacket and is controlled by a simple steam-pressure regulator. High pressures are needed to get high temperatures.

Motor drives

For maximum flexibility, a continuously - variable - speed drive should be provided. The following factors are important:

1) Good speed regulation. Speed regulation is the ability of a motor drive to maintain its pre-set speed regardless of load. Motors with poor speed regulation tend to cause output rate fluctuations, and sometimes even cause pulsations with every screw revolution. About 2% change in speed from no load to full load is considered ample for critical applications.

2) Wide speed range (1.7:1) at full horsepower.

3) Remote speed control. This is highly desirable from an operational standpoint, so that an extruder may be controlled from a point near the die where the effect of speed changes can be observed.

Not all the available drives fulfill the extruder-drive requirements equally well. The following is a survey of drive types:

1) AC-DC drive. Here a motor-generator set provides direct current to drive a DC motor. This drive has excellent speed regulation when a feedback regulator is used. It is available with a wide full-horsepower range. Speed range at reduced horsepower is usually about 12:1. It is the costliest type of drive.

2) Magnetic clutch drive. This drive uses a single-speed AC motor with a variable magnetic coupling. Speed regulation is excellent when feedback regulation is provided. This system is available with a wide full-horsepower range, and can be operated from zero up to full motor speed. It is considerably less costly than AC-DC drives in the higher horsepower ranges.

3) Brush-shifting AC motors

can be obtained with good speed regulation, but have only constant-torque characteristics, i.e., horsepower output is low at low speeds. The usable speed range is only 3:1. These drives are widely used in Europe, but in the U.S. they are almost as costly as the much superior AC-DC drives and offer no advantages.

4) Mechanical speed variators. Here a pair of conical sheaves or gears are linked with a special belt or chain. The drive uses a single-speed AC motor. The speed range is about 5:1, but speed regulation is only fair (about 8%) and output power falls with falling output speed. Units up to 50 hp. are available and they are widely used because of their low cost.

5) Gear shifting. This drive has been used in some European designs in conjunction with single-speed AC motors. Speed change in steps is generally undesirable for starting up and operation.

Dies

Much work has been done on improving the precision of extruded products by better die design. Besides the standard types of dies for the extrusion of shapes, many specialized dies have been developed for the extrusion of film, sheeting, and pipe. Rheological analyses of sheet and film dies are progressing to the point where heat-sensitive materials, such as the vinyls, will soon be extruded in direct competition with calendering. Cooled-mandrel pipe dies are becoming standard in most installations. Wire coating and other continuous coating operations are generally performed on cross-heads where the material to be coated passes through a head which is at right angles to the extruder center line. A new development is the 30° cross-head which permits straight-head, cross-head, and cooled-mandrel pipe extrusion, all in the same direction and with a minimum of hot material inventory and deflection.

Take-offs

A variety of take-offs accommodates different types of end products. In each case it is the object of the equipment to cool the product while maintaining or improving its dimensions and appearance. The output of an extruder is frequently limited by inadequate take-off equipment.

Variable-speed conveyors with or without water cooling are widely used for extruding tubing, tapes, and profiles.

Wire and cable is usually water-cooled and is pulled off with capstans onto reels. Automatic change-over and speed control devices are available for continuous high-speed operation. More recently a caterpillar-type pull-off has been used for large-diameter cable and pipe. This offers strong positive traction without distorting the cable.

In the extrusion of sheet and film, highly developed haul-off units not only cool the product, but also improve the surface finish. Some can even overlay a laminate. Another type of take-off is widely used for the extrusion-coating of paper, etc. These take-offs are usually provided with automatic shears, edge trimmers, and stackers or wind-ups. Some surpass the extruder in cost and complexity. Beta-ray and other precision gages are becoming common for continuous product inspection and control.

Tubular film is made by inflation or drawing over a cooled mandrel.

References

For further information on extrusion and equipment for extrusion of specific thermoplastic materials, consult the section starting on p. 704. Also consult the Subject Index, and the Directory Index, p. 1018.

"Extrusion dies and take-off equipment," K. O. Robbins, MODERN PLASTICS *33*, 125 (Dec. 1955).

"A new look at extrusion," H. O. Corbett, MODERN PLASTICS *31*, 198 (June 1954).

"Solids conveying in extruders," W. H. Darnell and E. A. J. Mol, SPE Journal *12*, 20 (Apr. 1956).

"Symposium on the theory of extrusion," J. F. Carley et al., Ind. Eng. Chem. *45*, 969-93 (1953).

EQUIPMENT FOR LAMINATING

BY G. R. ECENBARGER*

Equipment for producing laminated materials[1] is quite varied but, in general, falls into four categories: 1) impregnating and drying equipment; 2) cutting or sizing equipment; 3) pressing and laminating equipment; and 4) fabricating and finishing equipment.

Impregnating and drying

The impregnation of raw cloth or paper stock is performed in equipment designed to maintain the proper ratios of resin impregnation and advancement of cure of the contained resin, depending upon the ultimate end use of the finished product.

The base paper or cloth, which is usually received in roll form of varying widths, is mounted on an unwind stand and threaded through adjustable tension rolls and around a dip roll immersed in liquid resin whose viscosity is controlled by solvent content or temperature. The wet stock then passes between heavy steel rolls, mounted so that clearance is accurately adjustable within 0.001 inch. These driven rolls uniformly distribute the resin through the web and squeeze out excess resin. In some cases, wiper bars are used for this purpose, either alternatively or in conjunction with squeeze rolls. The wet web is then conveyed on a cross-slat conveyor through a long tunnel dryer.

The treated and dried material is cooled in a cold-air circulating section of the dryer just prior to emergence, or by passing the material over water-cooled rolls, which may also serve the purpose of pulling the material through the oven. The treated material is then wound on either cores or drum winders driven by friction clutches, adjustable to maintain tension on the material and to ac-

* Manager, Facilities Engineering, General Electric Co., Coshocton, Ohio.

[1] For details of the laminating process, see "Laminates and Laminating," p. 506.

Recent Developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

A 2200-ton laminating water-hydraulic press has a platen area of 80 by 38 in. and 10 between-platen openings. The standard model operates off the customer's existing accumulator system, at 2500 p.s.i. (max.) but a self-contained oil-hydraulic system will be furnished if desired. The 11 hot plates are cored for steam, the cooling plates for water. Daylight of each opening is 3.5 in., and when the press opens each platen returns to a given position. This permits using a specially adapted elevator with the press that greatly reduces unloading and loading time. Maximum daylight is 77.8 in., stroke is 36 in., and the rams are 34 in. in diameter. *Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.*

A machine that combines the forming and laminating operations in making countertop bends is rugged but simple in construction. The built-in heater consists of two rod-type elements totaling 15 ft. in length. Sheet up to 12 ft. long can be handled in any width. *Trinity Industries, 2910 Bay Rd., Redwood City, Calif.*

A continuous postforming machine for laminates, particularly Formica, utilizes dielectric heating in rolling angles from flat strips of laminates. The machine is capable of producing angles 1 by 1 in. minimum to 4 by 4 in. maximum, up to 10 ft. in length. Operation is said to be completely automatic. The laminate is heated to about 300° F., formed by rollers, and cooled to set the shape. It is possible to bend $\frac{1}{16}$-in.-thick Formica, for example, to a $\frac{3}{32}$-in. radius, with no springback, at rates of about 20 ft./minute. *Faratron, Inc., 4447 Union Pacific Ave., Los Angeles 23, Calif.*

complish the winding of a tight roll. In some cases the stock will be sheared to size and collated directly from the treater, instead of being wound into roll form. For this purpose, conventional shearing equipment of either the stationary or traveling type is used, synchronized with the speeds of the treater.

Recently, to get better uniformity, beta-ray gages have been used as a measuring device.

Cutting and sizing

Conventional paper cutting equipment is used for cutting material from rolled-up webs. Rotary cutters and stackers, slitting equipment capable of handling one to six rolls simultaneously, and trimming shears, either power- or hand-operated, are used. To make macerated stock, the material is fed through rotary fly-knife cutters that reduce the stock to irregular pieces.

Pressing and laminating

Pressing of laminated sheets is performed in high-pressure hydraulic presses. These presses are capable of exerting up to 2000 p.s.i., over surface areas up to 50 sq. feet. This is massive equipment and very often, in the cases of 10- to 15-opening presses, may weigh as much as 200 tons and stand three stories high. The larger presses will have as many as eight to ten 24-in. hydraulic cylinders to distribute pressure uniformly over the entire pressing area.

The press platens are usually 3 to 4 in. thick, and are channel-drilled or cored for steam and water to provide alternate heating and cooling cycles. These platens, with the press in the open position, are supported on stepped ladders to maintain a spacing of 3 to 5 in. to accommodate the unpressed build-ups. To allow for movement of the platens as the press closes, flexible metal hose or rotating joints connect the individual platens to steam, water, and waste headers. The laminating process requires uniform heating of the press and contents. This is done by passing steam or hot water under controlled pressure through the channeled platens. When curing is complete, cold water replaces the heating medium, and the press is cooled as quickly as possible. Control of the heating and cooling cycles may be performed manually, but the trend is toward automatic cycling and control.

Rods

Rods are produced on special equipment that winds a continuous strip from the roll onto a small-diameter chrome-plated mandrel. The mandrel is supported between three heated and driven rolls under pressure, in order to soften and compactly bind the laminating material. Upon withdrawal of the mandrel, the resulting tube is further cured and densified to a rod in a heated mold under hydraulic pressure. Centerless grinders then reduce the rod to the required size and finish.

Noncircular rod forms, used as wedges, motor and generator commutator spacers, and other special applications, are produced by molding stacks of flat strips in multi-cavity molds. The cured moldings are parted with gang saws and a final milling or finishing operation removes flash.

Tubes

Tubes are produced on equipment similar to that used in the molding of rods as described above, except that a chrome-plated mandrel of a diameter equivalent to the inside diameter desired in the finished tube is used. The mandrel is not withdrawn until curing is complete.

Molded shapes

Molded shapes for special applications are produced in molds with chrome-plated cavities. It is usually necessary to premold macerated, treated cloth stock in order to reduce bulk. This premold is then further densified and cured in a subsequent compression molding operation, which will produce the final dimensions and finish characteristics. Several premolds can be combined into one final molding, and complicated shapes, possessing high impact and structural strength, can be produced.

With the exception of certain

special laminations incorporating glass or other ceramic fibers, which must be processed with abrasive cutting tools and equipment, the bulk of laminated products may be processed on conventional wood- and metal-working equipment. Either saws, or shears, equipped with high-speed steel or Carboloy blades, may be used to trim and shape sheets up to ⅛ in. thick; heavier materials are handled almost entirely by sawing.

Rotary shears are used for producing strips from the thinner materials in large quantities, as required for automatic punch press operation. Drum sanders are used to size boards and sheets to close specifications and to produce surfaces adaptable to gluing.

EQUIPMENT FOR COATING

BY R. C. STURKEN*

One of the more important uses of plastics and resins is in the form of coatings applied as thin films to other materials.

For the application of plastics coatings to flexible webs of material there are several basic methods which can be used. The first and oldest involves the use of a solvent solution, dispersion, or water emulsion of the resin. The second method involves melting the plastic material to a liquid state of moderate viscosity and applying it directly, without dilution, as a hot melt. The third method involves the direct extrusion-coating onto the web.

A wide variety of coating machines has been used for applying solution, dispersion, emulsion, and hot-melt coatings. The same equipment can be used for all of these materials in the low-to-medium viscosity range, except that for hot-melt materials the coating rolls, pans, and other parts are heated.

Perhaps the oldest and simplest type of coater is the knife coater. This coater includes a coating knife which scrapes against the web and meters the amount of plastic material being applied. Four arrangements of knife coaters are shown in Fig. 1, right. This equipment is simple and inexpensive but does not give accurate control of coating thickness and is subject to streak formation.

Roll coaters

Various types of roll coaters can be used for applying plastic materials to webs. Of these, the reverse roll coater is the most accurate and at the same time the most versatile. Various arrangements of rolls used in reverse roll coaters are shown in Fig. 2, p. 904. On this machine the coating thickness is accurately metered between two precision-ground chilled iron rolls, and the thickness has been found to be relatively independent of viscosity, speed, web tension, and web surface.

Air knife coater

The air knife coater, also known as the air coater or air brush coater, has recently been finding increased usage in the application of water emulsions and dispersions of plastics materials. In this type of machine, a coating is applied by means of a roll and is then smoothed and doctored by a blast of air from a precision slot.

The development of film-forming water dispersions of high solids content of such materials as polyethylene and polyvinylidene chloride in Europe has led to the adaptation of the air coater for these products to a greater degree than in the United States where such formulations are not yet available. This process has the advantages, of course, of not using expensive or flammable solvents as diluents.

Gravure print coater

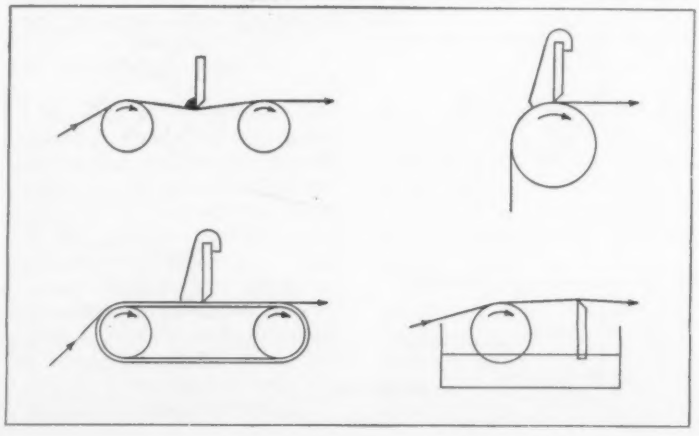
Another specialized unit for applying very thin coatings is the gravure print coater. This machine is designed so that it picks up the coating with a doctored engraved roll and then prints this coating on to the web. This type of unit is very accurate but is limited to thin coatings and is relatively inflexible for producing various coating weights.

Drying

On all coatings containing water or organic solvents, a drying tunnel must be used after the coater. The heat can be furnished by means of recirculated hot air or by various types of infra-red heaters, or a combination of both. On plastisol coatings containing no solvent, it is merely necessary to heat the material to fuse the coating, while in the case of hot-melt coatings the material is cooled with either air cooling, water-cooled rolls, or with a combination of both.

For the direct application of high-viscosity film-forming plastics to continuous webs, the so-called direct extrusion coating or extrusion-lamination process has

Fig. 1: Four knife coater arrangements. Knife meters amount of coating



*Frank W. Egan & Co., South Adamsville Rd., Somerville, N.J.

References were prepared by the editors.

Recent Developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

Bench-type coater is designed to coat sheet materials such as plastics, plywood, fabrics, etc., up to 1.5 in. thick, with paint, adhesives, and so on. Several models are available: there are single top coaters, bottom coaters, and two double styles in lengths from 8 to 52 inches. A uniform-thickness coating can be applied at rates up to 3800 linear ft./hour. *L. R. Wallace & Co., 191 N. Pasadena Ave., Pasadena 3, Calif.*

The Whirlclad process consists of immersing (hot) objects to be coated with plastic into a fluidized bed of specially formulated polymer and metal powders. The sensible heat of the object will in many cases be sufficient to fuse a continuous plastic coating over its surface. Where it is not, post-heating completes the fusion. Metals, ceramics, glass, and wood articles may be so coated. Tanks range in size from 7 in. in diameter and 8 in. high to rectangular ones 39.5 by 39.5 by 79 inches. Advantages of the process over melt and solution coating are: superior penetration of coatings into contours, no beading, no thinning. *Polymer Processes, Inc., 125 N. 4th St., Reading, Pa.*

Available in four models, the Walco bench-type coater is designed to coat sheet materials, including plastic sheeting, with paints, adhesives, etc. All the rolls —some steel and some rubber— are power-driven by a ¼-hp. motor; the rubber rolls are available in neoprene, thiokol, or Hycar, in lengths from 8 to 52 inches. Grooved rolls are available for use with heavy adhesives. *L. R. Wallace & Co., 191 N. Pasadena Ave., Pasadena 3, Calif.*

come into wide usage during the past five years. This process has found its largest use in the manufacture of polyethylene-coated paper, cellophane, and aluminum foil.

Extrusion-lamination

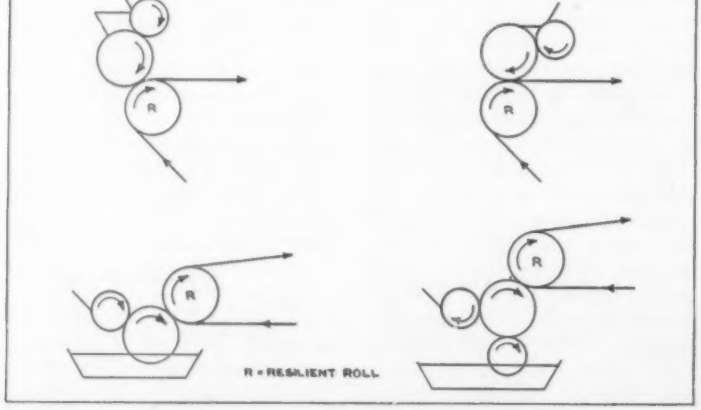
In the extrusion-lamination process, the resin is first extruded in an essentially standard extruder. Because high extrusion temperatures (600° F. or higher in the case of polyethylene) have been advisable in order to obtain maximum adhesion of the coating, the electrically-heated extruder is the most widely used in this industry.

An extrusion-lamination machine, as shown in Fig. 3, p. 905, discharges the plastic into a horizontal sheeting die which forms the resin into a thin film. The hot extruded film is laminated directly onto the paper or other web to form a continuous coated sheet, with a specially designed film laminator. This unit consists of a water-cooled roll and rubber pressure roll located directly beneath the sheeting die.

The water-cooled roll is specially designed so that all of the heat can be removed from the plastic on a single roll rather than requiring a series of rolls; otherwise, the coating will adhere to the roll. The outer surface of the roll can be given a highly polished chromium-plated finish or a matte finish, depending upon whether a glossy or dull coating is desired.

As in the manufacture of plastic film by extrusion through a flat sheeting die, the edge of the film thickens when it is stretched after leaving the die. This condition makes it necessary to trim this heavy portion from the coated material before it is wound up. With the techniques originally used it was necessary that the web be wider than the extruded film to prevent adherence of the plastic to the rubber pressure roll. This resulted in the production of considerable waste which could not be reclaimed. Recent techniques have been and are being developed, however, using special silicone rubber compounds and special roll designs, so that the film can be extruded wider than the web. Under these conditions the heavy edge can be trimmed off as pure plastic and can be reclaimed.

Fig. 2: **Reverse roll coaters; coating thickness is metered between rolls.** (Sketches in this section, Frank W. Egan & Co.)



Coating rigid materials

Many paints, varnishes, enamels, and lacquers contain synthetic resins and plastics materials, and hence films of these materials can be considered plastic coatings. They can, of course, be applied by the well-known conventional methods of brushing, spraying, and dipping, and will not be treated further in this article.

More recently, however, techniques have been developed for direct application of thermoplastic materials to metal surfaces without the use of solvents or diluents. Such processes will, of

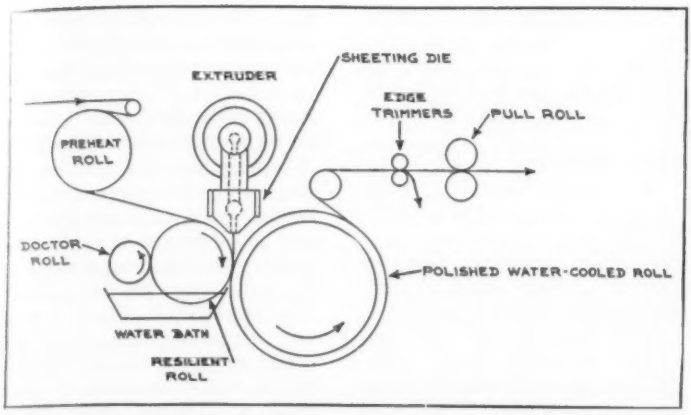


Fig. 3: Extrusion-laminating machine; extruder feeds film to laminator unit

course, have important economical advantages in cost of application and in ability to produce thicker coatings, and are particularly advantageous for plastics which cannot readily be dissolved.

The principal methods used for direct application of plastic coatings include *direct fusing of powdered resin* and *flame spraying*.

In the application of fused powder coatings, the plastic is first reduced to a finely powdered state suitable for fluidizing. A charge of powder is then fluidized by means of compressed air in a fluidizing chamber. The object to be coated is heated in a conventional oven to a temperature above the melting point of the plastics (400 to 500° F. in the case of polyethylene). It is then immersed in the fluidized bed of plastic powder for a period of 5 to 20 sec., depending upon the thickness of coat desired.

The coated object is then generally given a post-heating treatment in the oven to complete the fusing and leveling of the outer surface of the powder deposit. Thicker coatings can be obtained by repeated heating and dipping of the article. Prompt quenching in water is advisable since plastics are susceptible to oxidation.

Flame spraying

In the case of objects and surfaces which are too large to be immersed in a fluidized bed, flame spraying of powdered plastic is used. The surface to be coated should again be preheated before it is ready to receive the plastic.

The plastic is reduced to a powder form for feeding to the spray gun. In one type of spray gun, a suction is generated by means of a venturi, and this picks up the powder which is fed into the induced air stream from a hopper through an orifice. In another system, the powdered plastic is fluidized and is fed under pressure from the fluidized bed into the spray gun.

A flame is generated in the spray gun by means of compressed air and acetylene or other fuel gas, and the plastic powder is sprayed through this flame onto the surface being coated.

This same spray gun may be used as a torch for preheating the article to be coated, in which case a neutral flame is used. When the actual coating is being sprayed, however, a reducing flame must be used in order to prevent oxidation of the plastic being used as the coating.

The plastic powder is partially melted as it is propelled through the flame and the fusing is completed when it strikes the preheated surface which is being coated.

References

For further information on materials used in coatings, see "Resins for Coatings," p. 175; on extrusion and extrusion equipment, pp. 704 and 898. Also consult the Subject Index and the Directory Index.

Web coating

G. Hagen, World's Paper Trade Review *147*, 253 (Jan. 24, 1957).

E. C. Bernhardt, Tappi *39*, 366 (June 1956).

G. L. Booth, Tappi *37*, 157 (July 1954); 163 (Oct. 1954).

C. W. Patton, Paper, Film & Foil Converter *27*, 17 (Dec. 1953); *28*, 23 (Jan. 1954).

R. C. Sturken and L. W. Egan, Tappi *36*, 38A (June 1953).

R. F. Vokes, Tappi *36*, 64A (June 1953).

L. M. Burgess and L. F. Swec, Modern Packaging *26*, 151 (Sept. 1952).

D. R. Erickson, Modern Packaging *24*, 107 (July 1951).

L. F. Swec and H. L. Clack, Tappi *35*, 88 (Mar. 1952).

Flame spray and powder coating

J. A. Neumann, Yale Scientific Magazine *31*, 18 (Dec. 1956).

B. Goldberg, Corrosion Engineering (April 1950).

W. B. de Long and E. V. Peterson, Chemical Engineering (June 1949).

EQUIPMENT FOR CALENDERING

BY KENDRICK J. GOOCH*

The degree of quality and economy obtained in calendering plastics film and sheeting depends largely on the amount of careful planning entering into the design of the complete calender train. Material should flow from resin storage through the processing operations to packaged rolls of finished goods with a minimum of human effort. The size of related train components, e.g., mixers and mills, conveyors, calendering rolls, etc., should be in proportion, both to production requirements and to each other, so as to be used at their maximum rate of output.

Primarily, the process of calendering is used to densify the resin and to produce a desired thickness and surface finish on a given film or sheet of material. This operation is performed be-

* Asst. Div. Engineer, Mill and Calender Div., Farrel-Birmingham Co., Inc., Ansonia, Conn.
References were prepared by the editors.

tween two or more pairs of rotating beams called rolls. Each roll pair constitutes a rotating die through which the material is either drawn or extruded, or both.

Mixing the resin

The initial step in the calendering operation is the mixing of the resin. Various types of intensive mixers and mills are available that can be arranged to suit specific production requirements.

The tower type of preblending arrangement, for example, is one that requires a minimum of material handling. Resin is blown through piping or elevated in bags to high storage bins. It drops from the bins onto shaking screens, flows by gravity through sifters and into traveling weigh hoppers which feed the blenders, and from the blenders pours into weigh hoppers located directly above a Banbury mixer hopper door.

If both film and sheeting are to be produced with the same calender train, good results can be obtained by using a setup such as is shown in Fig. 1, below. In this arrangement, two 3A Banburys are installed with the hoppers facing each other. One operator can thus control both units for producing sheeting, and a single unit can be used at maximum capacity for the thin-gage films.

To obtain a wide range of finished gages, two mills can also be used. One of these mills should be mounted directly under a Banbury. The second should be opposite the first, so that the adjusting screws are on adjacent sides and one operator can control both mills. Material is carried by strip-feed conveyor (a narrow, flat-bed, hugger-type unit) from the first mill to the second, and then to the calender feed bank. The calender can also be supplied directly from the first mill.

Metal detection

In setting up calendering equipment, it is important that provisions be made to keep metal-contaminated material from being fed into the calender where it would mark up the calender rolls.

When using the strip-feed conveyors described above, small-gap, sensitive metal detectors can be easily installed along these conveyors. Strip conveyors can also be designed to cut out and discard automatically a length of material containing a metal particle with a minimum of lost feed to the calender. This is essential for high-speed calendering.

A more positive means of metal elimination is obtained by using an extruder with a strainer-type head. This method is relatively expensive since a large unit having an adjustable-speed drive, synchronized with the calender speed, is required. Moreover, the strainer removes all solid particles, not just metallic objects. Where surface finish is important, the higher initial cost is offset by the savings effected by eliminating possibilities of roll damage.

Calendering rolls

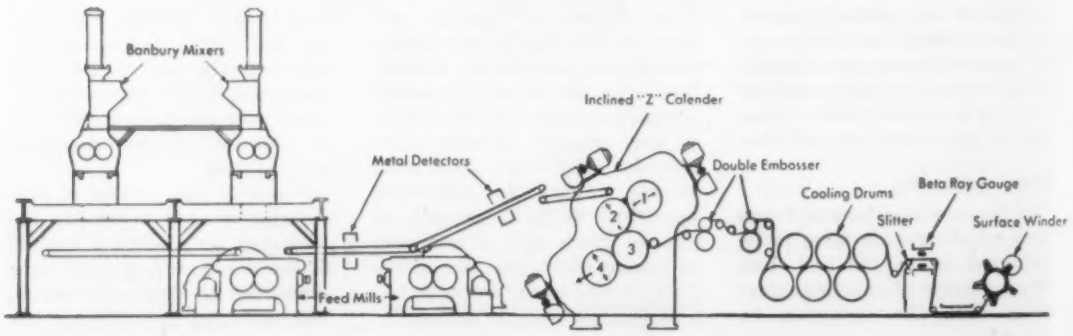
The latest trend in plastics calendering is toward calenders designed for higher roll temperatures, greater roll separating forces, and a wider range of available friction ratios.

Several types of roll arrangements are available for selection on the basis of ease in threading, accessibility of the rolls, and general convenience. The "Z" and the inverted-"L" arrangements are standard in the industry. A recent development is the inclined "Z" which provides a clear and short path for material travel, permits easy accessibility for coating fabrics, and enables the embosser or other attachment to be placed close to the pick-off roll. As shown in Fig. 1, below, this calender incorporates the necessary feature of crossed-axes on the No. 4 roll, with the material being taken off the No. 3 roll instead of the No. 4 roll, as with previous calender roll arrangements.

Few plastic calenders are designed to make only a single size of sheeting from a single stock. Usually, the maximum flexibility is desired so that thin films and heavy sheeting can be produced to satisfy market requirements. This, in turn, means the rolls will be subjected to a wide range of separating forces. These forces bend the rolls, changing the shape of the aperture between them. If some compensation for this bending were not made, the sheet thickness would vary considerably over its width. To keep the sheet flat, two techniques of compensation are used. In one—roll bending—an opposing bending moment is applied to the rolls. In the other—roll crossing—one roll axis is crossed slightly with respect to the other by causing it to pivot about its midpoint of length.

Several calenders recently built are equipped with individual motor drive for each roll. This is accomplished either by connect-

Fig. 1: Typical calendering setup designed to be used when both film and sheeting are to be made with the same calender train



ing each roll directly to a gear-motor through a universal spindle, or by using a semi-uni-drive between the gear motors and the spindles. Both of these arrangements provide a wide range of roll friction ratios which are advantageous for the newer types of plastics compounds. Since these compounds require high power at slow speeds, calenders, driven by motors having a low base speed, have been designed for calendering rates up to 100 yd./minute.

Material coming from the calender should have a reverse wrap around closely spaced carrier rolls to prevent pull-down in width. Free-turning rolls with spindles driven to eliminate friction are required near the calender.

The recent trend in post-calender embossers is toward double or turret-type units in order to provide a quick change of pattern. The type of embosser required depends on the embossing pressure and whether or not the rubber roll, as well as the embossing roll, must be frequently changed. High-pressure embossing at top calender speeds requires a heavy-duty driving motor.

Cooling rolls are usually driven in groups of three for best speed control. The number required depends on the heat to be removed and this is proportional to the sheet thickness and production rate. Slow-speed film calenders may have only three cooling rolls, whereas high-speed sheeting calenders will have nine or more.

Many calenders now have two-speed, motorized roll adjustment with the low speed designed for use with automatic gaging. Beta-ray gaging equipment has now been designed to control not only the longitudinal and edge gage, but also the entire profile. In automatic profile control, the Beta-ray gage governs the roll-crossing or roll-bending equipment.

Calender wind-up

The type of winder is usually determined by the gage of material of primary interest. Film tensions are readily controlled on a surface-type winder. Large rolls of sheeting may be better handled on a two-arm center winder. For both types, the material should be cut off and started on the new roll as automatically as possible. Winders for coated fabric must have special cutters in order to cut through both plastic and fabric without reducing the calender speed.

Drilled rolls and circulating-liquid temperature control are an accepted part of almost all plastics calender installations. Now, mills, and in some instances Banbury mixers, are also commencing to be controlled in temperature by similar systems.

References

"Designing better calenders," by Kendrick J. Gooch, MODERN PLASTICS *34*, 165 (Mar. 1957).

"Roll bending," by M. Jukich, MODERN PLASTICS *33*, (Apr. 1956).

"Thickness control by beta gages," by Gilbert Corwin, MODERN PLASTICS *32*, 104 (Mar. 1955).

EQUIPMENT FOR MOLD MAKING

BY ISLYN THOMAS*

No matter how carefully a mold is designed, it will not produce satisfactory molded parts unless it has been constructed with the utmost care and skill. Molds and dies for the production of plastics parts are generally made of metal, with components produced by machining, hobbing, casting, electroforming, and metal-spraying.

In order to machine these metal molds, practically every type of machine tool may be used.

Auxiliary equipment

Many types of auxiliary equipment are necessary for making molds. Filing machines, hand grinders, tool grinders, welding machines, laps, and hardening equipment are among the items necessary for precision tool work. Hand grinders are used to add finishing touches to hardened molds.

One very important operation is hand filing of corners and curves which cannot be cut out with end mills. Since hand filing is naturally a slow, expensive operation, work of this nature should be held to a minimum.

To remove tool marks, holes and irregularly shaped depressions are smoothed by hand stoning with silicon carbide abrasive sticks of progressively finer grits.

Polishing machines consist of a stand that holds a small motor operating a flexible shaft to which may be attached polishing brushes or small grinding wheels of aluminum oxide abrasives.

Lap sticks, brushes, wood sticks, and felt bobs are used with diamond compounds to grind hardened or unhardened molds and bring them to a high finish.

Shapers and planers

Shapers: The shaper is a straight-line cutter of the planer type. It performs a large variety of operations, such as squaring up mold plates and making them symmetrical in shape and properly sized. The feed-motion of shapers may be given either to the cutting tool or to the work. When the cutting tool is moved, the machine is described as a travel-head shaper.

Planers: If a large enough shaper is not available for squaring up mold plates and cutting out large cavity blocks, a planer serves the same purpose. The fundamental difference is that planed work is bolted to the machine table which reciprocates while the tool remains fixed. Large planers will machine several surfaces simultaneously.

Lathes

The lathe, in the last few years, has undergone many improvements and transformations, thus widening its scope and very greatly extending and expediting its operations. Among a bewildering variety of lathes, many of which are specialized, probably the most familiar is the engine lathe, which, with special attachments, is known as the toolmaker's lathe.

Whereas a shaper or planer is used to form plane surfaces, a lathe is used to form pieces with circular cross-sections. Cutting

*General Manager, Newark Die Co., 20 Scott St., Newark 2, N.J.

Recent developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

Moldtem, a new mold and die steel, is a chromium-molybdenum-vanadium alloy that comes prehardened and ready for use without further heat treatment. The hardness ranges from 302 to 341 Brinell. Moldtem is claimed to have maximum polishability and is easy to machine. A combination of chemical composition and careful quality control helps to eliminate the tiny pit-producing bubbles characteristic of many steels. These pits cannot be polished out or filled by plating. *Heppenstall Co., 4620 Hatfield St., Pittsburgh 1, Pa.*

Poly-Flex 100, a polymer-based mold compound in liquid form, has been developed for making flexible molds over plastics, wood, metal, clay, or wax patterns. The resin is mixed with a curing agent to give a low-viscosity liquid that molds very faithfully and cures in 4 hr. at room temperature. *Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N. J.*

Six new standard sizes of mold bases have been announced by DME. In all six, one dimension is 23.75 in., and all are available in a range of heights from 9.9 to 16.4 in. The remaining lateral dimension, for the six bases, is: 14.9, 16.5, 19.5, 23.75, 29.5, and 35.5 inches. Special features: clamp slots to save platen space, tubular dowels that leave more room for coring, stop pins that are welded to the ejector bar, and one-piece ejector housing. *Detroit Mold Engineering Co., 6686 E. McNichols Rd., Detroit 12, Mich.*

tools for lathe work are somewhat similar to shaper tools and are held in what is known as the tool-post. The tool-post is part of the carriage and is movable in two directions by means of screws.

The lathe will turn outside and inside surfaces and will cut both inside and outside threads. The lathes used in mold making range in size from small bench lathes for pin work to large ones for turning big dies, such as reflector molds, etc. The lathes especially designed for form and contour turning have all their speeds and movements controlled by individual electric motors.

Attachments available for lathes include internal and external grinders, milling attachments, special holders, and chucks.

Milling machines

Both vertical and horizontal milling machines are considered standard equipment in a mold making shop.

Vertical milling machines: Perhaps the most important of the milling machines for mold and die making is the vertical-spindle miller, available in many sizes and styles, from small hand-feed types to large multiple-spindle machines with automatic profiling and depth control equipment. The latter device automatically duplicates cavities of any shape, either from templets or from master molds. All varieties have a table which provides a longitudinal feeding motion. On some types, cross-feeding motion is available.

A two-, three-, or four-toothed cutter of the end-mill type fits in the milling machine spindle; it fits either directly or can be fitted by means of chucks or quick-change collets.

Rotary-head milling machines: The rotary-head milling machine embodies all the characteristics of the vertical milling machine plus many other features.

The rotary head, the spindle slide, and the transverse and longitudinal travel of the table provide all movements necessary to cut any profile that the draftsman can draw by the use of the straight-edge, protractor, and compass.

Saws

In the preparation of the various cavities and backing plates for the mold, steel has to be cut from bar stocks, special forgings, billets, or plates. The plates must be prepared for the machining of the cavities. In order to put them into the desired shapes and sizes, the following machines may be used:

Power hack-saws: The most commonly used machine is the power hack-saw, which is a motor-driven saw, larger than the hand hack-saw, with a blade of high-speed steel. This saw is used to cut tough alloy steels.

Band saws: The common band saw, which at one time was considered merely a woodworking tool, has now become a high-grade metal-cutting saw. Band saws are of two general types: 1) those with tilting tables for simple cutting and angles; 2) those that will also cut intricate internal or external contours. A simple welding unit built into this machine quickly butt-welds its blades, when they have been cut for internal work.

Cut-off machines

The abrasive-wheel cut-off machine cuts small-quantity lots with extreme accuracy and high speed.

A rubber-bonded abrasive wheel, rotating at exceedingly high speed, is mounted in a counter-balanced, vertically swinging head and is brought down on the stock by means of a straight, almost effortless pull.

By means of the abrasive-wheel cut-off machine, the bar stock, laid unfastened upon the machine table, can be cut to length within a few mils without raising burrs.

Torches: The acetylene torch cuts with a jet of flame and can be used for cutting symmetrical as well as irregular shapes from stock up to and over 12 in. thick, depending on the pressure in the gas bottle. This rapid type of cutting is used mostly on soft machine steel.

Duplicators

At one time the design and production of a mold was left to the skilled tool maker, who used the general-purpose equipment available to him. Today, experienced tool shops specializing in mold making must consider the quickest

and most economical way of producing well-operating, dimensionally correct molds if they are to meet competition successfully.

This change of attitude has resulted in the introduction of duplicating machines. They provide a means of producing identical cavities in multiple-cavity molds of regular form and contour but, for making large numbers of heavy blocks, the hobbing method described below is more economical.

There are three basic types of duplicating machines—manual, electric fingertip control, and automatic—all capable of two-dimensional or three-dimensional work.

In two-dimensional duplicating, the operator generally places both hands on the lever which controls the lateral movement of the duplicator table in any direction, thereby permitting the tracing stylus to follow precisely the shape of the master that is being duplicated.

For manual duplicating in three dimensions, the operator uses his left hand to control the vertical movement of both the milling cutter and tracer spindle, his right hand to direct the lateral movement of the duplicating table.

Electric-control types of duplicators have sensitive fingertip control which determines the cable movement. Controls can be set for either roughing or finishing.

Automatic duplicating machine: Actually a powerful horizontal milling machine in which up, down, and lateral movements are operated by electrically controlled power feeds, this machine may be used both to profile in two dimensions or to reproduce reliefs in three dimensions. In either case, a tracer passes over the master form and the cutter duplicates the path precisely.

Drill presses

Single-spindle vertical presses, the most common machines for drilling holes in molds, may be either bench or floor models. These drill presses are made in several sizes, ranging from small, highly sensitive, precision models to units that will drill 3-in. and larger holes.

Radial drill presses, although vertical, differ from simple "verticals" in that the drill is moved from one location to another in a piece of work. A *universal radial drill press* has an arm which can be adjusted to drill at almost any angle.

Horizontal drill presses are of considerable value to the mold maker for drilling water or steam lines. The horizontal press permits simultaneous drilling of many holes up to 40 in. or more in length.

Jig borers

A jig borer is actually a combination drill press and vertical milling machine. It allows locating and spacing of holes with extreme accuracy, and is used for laying out the cavities of the mold.

Grinding equipment

There are many types of grinding machines designed for various purposes.

Jig grinders eliminate makeshift methods of correcting holes after hardening. They do away with dowel gages and end blocks, because the hole location is obtained through accurate, hardened guide screws, and thus makes any additional corrections unnecessary.

Vertical rotary surface grinders, rugged and rigid, are used principally for preparing flat stock for subsequent fabricating operations.

Reciprocating surface grinders, also used for flat stock, hold the work magnetically to the table while it is made smooth and parallel after shaping and hardening.

Centerless-type grinders are used principally for external grinding operations on cylindrical work requiring a high grade of finish and extremely close accuracy.

Many sizes are available accommodating work up to 60 in. in diameter and up to 24 ft. in length. There are two styles within this range: plain and universal.

As a general rule, plain machines are sturdier and are usually designed for high production work; "universal" machines are designed for a wider variety of work, including face, angle, and internal grinding. Taper and shoulder work can be ground on either style.

Cutter grinders: In precision milling, duplicating, or engraving work, cutters must be reground as often as 20 times per day to ensure accuracy. Cutter grinders, designed for such sharpening operations, are provided with graduated dials and adjustments.

A *pedestal* or *bench grinder,* consisting principally of a motor with a grinding wheel mounted on each end of its shaft, is required equipment for sharpening small tools.

Individual or central dust collectors must be provided for dry grinders and operators must wear shields in order to protect their eyes.

Machine engraving

The engraving of master hobs and cavities in the early days depended solely on the ability and skill of hand engravers. Today many types of engraving machines are available using pantographic devices with motor-driven rotary cutters. The machines are built very sturdily with micrometer adjustment for precision work and are generally equipped with adjustable pantographic ratios so that the equipment can be adapted to hundreds of different applications.

There are two main types of engraving machines in use today —two-dimensional pantographs and three-dimensional pantographs.

Two-dimensional pantograph: For the engraving of letters and designs, a two-dimensional pantograph should be used. The operation is quite simple after the enlarged master templet or copy is set up in the copyholder. The tracer, guided by the machine operator, follows the copy. In addition to working on flat surfaces, these machines can operate on concave, convex, and spherical surfaces, provided the curvature is relatively uniform and not too great.

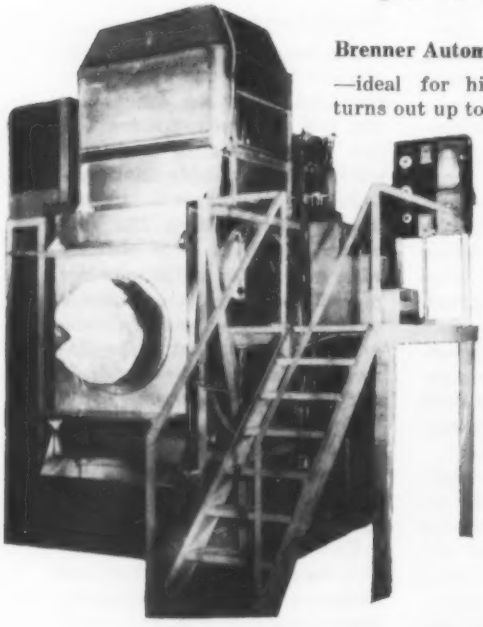
Three-dimensional pantograph: For engraving in three dimensions from enlarged models of any shape or contour, a three-dimensional pantograph is required,

Working with glass reinforced plastics?
Boost your production with BRENNER equipment

Cutters
Preform Machines
Ovens
Mat Lines

BRENNER machines are found wherever high production is a must. All BRENNER units are designed to minimize the operator's labor and to simplify quality control.

And you can call on BRENNER's Engineering and Consulting Service for sound, practical advice on any production problem dealing with glass reinforced plastics.



Brenner Automatic Rotary Preform
—ideal for high production runs—turns out up to 120 preforms per hour.

Automatic cycle timing with push button control.

Automatic spray guns, fiber distributor, and roving cutter.

Built in screen collectors for fan discharge.

Built in curing oven—only the preform itself has to be removed.

Get all the facts on the entire BRENNER *line—write for your copy of the* BRENNER *catalog. No obligation, of course.*

I. G. Brenner Co.
Special Machinery
32 East North Street, Newark, Ohio

which will also be capable of performing the work that is being done by a two-dimensional pantograph.

For three-dimensional work, a modeling bar is used. This bar, connecting the tracer spindle and cutter spindle, transmits the movement of the tracer as it passes over the contours of the model to the cutter spindle, reduction ratio being governed by the setting of the pantograph bars.

Hobbing presses

Hobbing is one of the best methods for insuring uniformity and economy in production of multiple-cavity molds and should be of great interest to all molders and mold makers. Owing to the tremendous growth in demand for hobbed cavities of all shapes and sizes, hobbing presses have increased in capacity from approximately 50 to 3000 tons and even more. A hobbing press is just a hydraulic press that is more sturdily built than ordinary presses because it has to deliver more concentrated force. Between its two platens is placed the mold blank, on top of which is placed the hob. To support the soft mold blank and keep it from spreading diametrically away from the hob while being formed, a hardened chase or hobbing ring is used. The ring is not necessarily round; it may be rectangular in shape.

On one-push impressions, the amount and location of relief is important; but it is on those impressions requiring two or more squeezes that the hobber's skill and experience, and the suitability of the hobbing press, really come into play. It takes only a few misguided seconds in a hydraulic press to ruin a hob on which many hours and many dollars have been spent. When hobbing is being considered it is wise to consult a good hobber before making either hobs or blanks.

Atomic hydrogen welding machines

Sometimes it is necessary to build up mold parts by the addition of metal. A cutter may take out more metal than it should, or a mold part may be worn or broken off in actual use. In order

to save this mold part, it has sometimes been found quite practical to weld with an atomic hydrogen torch.

Hardening equipment

Practically all mold parts should be hardened before using. Equipment for this work should consist of at least one carburizing furnace, one annealing furnace, one tempering furnace, and a small furnace for odd jobs. All furnaces should be equipped with good recording and control instruments.

Liquid honing equipment

To speed up polishing of mold cavity parts, they are generally abrasive-blasted to remove oxidation and discolorations which have been brought about by the annealing, hardening, or carburizing operations.

This "liquid honing" is a modified form of impact blasting in which an abrasive, suspended in a liquid, is delivered to the blasting nozzle by means of a circulating pump. The suspension, shot at the work by 90 p.s.i. air pressure, gives the surface of the mold a satin-matte finish. A short polishing operation restores the desired luster.

Chrome-plating equipment

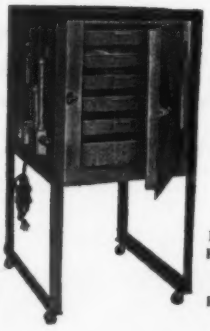
Chromium plating became an important factor in the tool industry when it was discovered that platings from 0.0002 to 0.05 in. thick would conserve steel by greatly increasing the life of hand and machine tools. Chromium plating gives the plastics industry the advantages of harder surface, less sticking, elimination of pitting caused by gases of reaction, reduction in breaking-in time, high finish of molded parts, and better flow.

Because of the plating characteristics of chromium, any defects in the mold surface are accentuated. This fact should be given serious consideration when setting up polishing procedures to assure good moldings.

Molds for such operations as vacuum forming, reinforced plastics molding, thermoplastic sheet forming, short-run pressure molding, etc., where mold and strength durability requirements

BROSITES OVENS and DRYERS

• SIMPLE AND FAST TO OPERATE



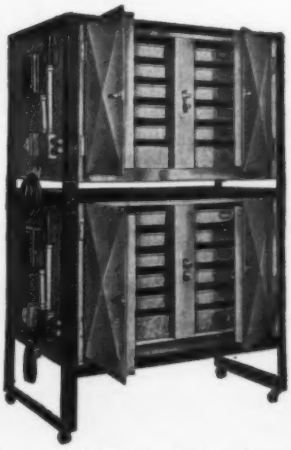
MODEL NO. 1
Single Door: Width 24½"
Five trays 15" x 22" x 2½"
Height 50"—Depth 28½"
Heating Element 1800 watts.
Thermostatic Control 100° to 300° F.



MODEL NO. 2
Double Door: Width 48"
Height 50"—Depth 28½"
Ten trays 15" x 22" x 2½"
Heating Element 3600 watts.
Thermostatic Control 100° to 300° F.

MODEL NO. 3
Double Decker:
Width 48"
Height 68½"—
Depth 28½"
Twenty Trays 15" x 22" x 2½"

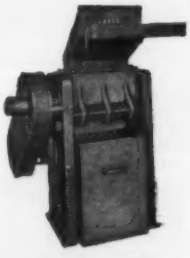
Model No. 3 is two Model 2 units placed one above the other. They can be operated independently of each other and the top unit can be used in reverse position whenever desired.



RUGGED, made to last . . . EFFICIENT, economical to use

The trays are of such size and design to hold approximately 10 pounds of the average material when placed to a depth of about one inch. Special trays of expanded metal allowing greater circulation of heat can be supplied and are recommended for the preheating of pellets and other solid objects. For special uses the trays, or the entire unit if required, can be made of stainless steel, monel metal or nickel. Sturdy in construction, built of steel sheeting, carefully and thoroughly insulated with rock-wool insulation placed between the inside and outside shells of the dryer. Mounted on casters for easy movement from one location to another in the plant. Each unit is equipped with thermostat to automatically control temperature of the oven. A light indicates when unit is in operation.

• JUST PLUG IN AND TURN THE SWITCH



DE MATTIA GRANULATOR
For the uniform grinding of Vinylite, Geon and all hard thermoplastics. Capacity: 200 lbs. per hr. 3 H.P. motor with double V belt drive. Four Steel Chopper Blades. Roller Bearings with Positive Seals. Screen with ¼" openings.



DE MATTIA *At The Machine* GRANULATOR
For at-the-machine operation Capacity: 75 lbs. per hr. 2 H.P. direct connected motor. Roller Bearings with Positive Seals. Screen with 11/32" opening.

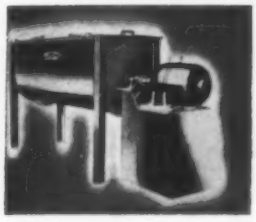


DE MATTIA CHUNK CUTTER
For low-cost salvage of larger slugs and chunks and molded pieces too tough for the average sprue and scrap grinder. Capacity: over 150 lbs. per hr. 3 H.P. motor in base. Double V belt drive. Roller Bearings with Positive Seals.

DE MATTIA INJECTION MOLDING MACHINES

BROSITES MACHINE COMPANY INC.
50 CHURCH STREET (Cable Address—BROMACH) NEW YORK 7, N. Y.

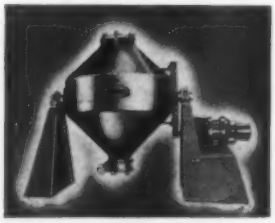
PAUL O. ABBÉ Grinding & Mixing Equipment for PLASTICS

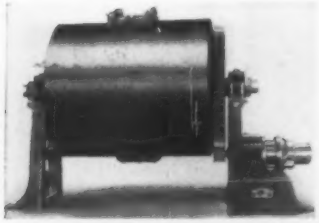


PAUL O. ABBÉ RIBBON MIXERS assure a homogeneous mix, are easily cleaned, operate at maximum capacity, and mix a wide variety of formulations without lumping.

For full details write for 20 page Catalog V-1.

PAUL O. ABBÉ DOUBLE CONE BLENDERS for dry, free-flowing materials are unmatched for blending efficiency, speed of blending, and overall economy. Write for our Catalog V-1.





PAUL O. ABBÉ BALL & PEBBLE MILLS have all-steel ends and forged alloy steel trunnions to eliminate end breakdown. The cylinders are lathe turned to assure perfect alignment of trunnions and gears and so keep power demands low. For full details write for 40 page "Catalog Y."

PAUL O. ABBÉ INC

257 Center Avenue, Little Falls, New Jersey

Your fast way of pre-determining the weathering qualities of a Plastic is in the ATLAS WEATHER-OMETER®

Test for resistance to sunlight, moisture, and thermal shock.
Results are accurate and reliable and can be reproduced precisely over and over again.
The Weather-Ometer furnishes a yard stick to measure the improved quality of a plastic in development and to maintain a standard of quality in production.
Automatic control of light, moisture, and temperature, can be set for repeating cycles according to the test program selected. A year of destructive weathering can be reduced to a few weeks of testing in the Weather-Ometer.





For Color Fastness only – use the Atlas Fade-Ometer®. Fully automatic in operation

Write for technical information and recommendations for your particular problem.

ATLAS ELECTRIC DEVICES CO., 4114 N. Ravenswood Ave., Chicago 13, Illinois



WEATHER-OMETERS • FADE-OMETERS • LAUNDER-OMETERS

are low, can be produced by spraying molten particles of metal onto a master until a durable shell of from ⅛ to 5/16 in. has been built up. This is accomplished with a special spray gun designed to feed metal rod through a high-temperature flame, then blow the molten metal particles onto the pattern.

References

"When and how to hob," by Islyn Thomas and Edmund Spitzig, MODERN PLASTICS *32*, 117 (Feb. 1955).

"Solving big mold problems," by Islyn Thomas, MODERN PLASTICS *31*, 189 (June 1954).

"Injection Molding of Plastics," by Islyn Thomas, 1947. New York: Reinhold Publishing Corp.

EQUIPMENT FOR COMPOUNDING AND COLORING

In general, compounding and coloring thermoplastics requires at least four steps: 1) weighing ingredients, 2) mechanical blending, 3) plasticating the mixture, and 4) cutting the finished compound into usable particles. At least one piece of equipment will be required for each step. Not infrequently, where a particularly thorough mixture is desired, two types of equipment—a Banbury mixer and milling rolls—will be used for the plasticating step.

In some cases it may be possible to eliminate one or more of these four steps, with a corresponding reduction in the amount of equipment needed.

The choice of equipment for each of the four compounding stages will depend in part on the quantity of compound desired and the speed of production. The nature of the thermoplastic being compounded and of the other ingredients will also play a part in determining the type of equipment required for each stage. Finally, the form in which the compound is to be fed to the molding or extruding machine will affect the choice of equipment for final cutting.

Weighing equipment is re-

Recent Development excerpted by the editors from MODERN PLASTICS.

quired for the first step in any compounding or coloring operation, unless the desired proportions happen to be such that the batch can be made up from preweighed contents of bags, drums, or other shipping containers. Even in such a case, check-weighing may be desirable to assure accuracy.

The type and size of scales used will vary widely with the nature of the operations. For the coloring of polystyrene crystal in a molding plant, small balances will generally be all that are necessary to weigh out the small amounts of colorants required. At the opposite extreme are the large enclosed scales required by materials manufacturers for weighing all the ingredients for great batches of compound.

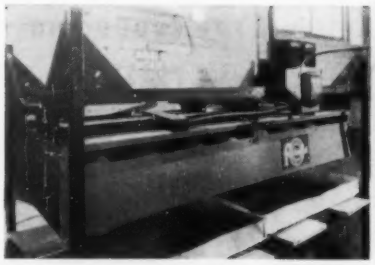
Premixing or blending

In any compounding or coloring operation, the properly weighed amounts of the various ingredients must first be mechanically blended before the mixture can be satisfactorily masticated. The material in the premixer may be wet or dry, depending on the type of plasticizer used. Some premixers, it will be noted, can handle either wet or dry mixtures, while others are suitable only for dry blends. Another major distinction may be made between mixers with internal moving elements to do the mixing and those in which the whole mixing chamber revolves.

Tumbling blenders: The tumbling blenders, which handle only dry mixes, are of many types, but in all of them the mixing is achieved by some type of turning action of the chamber containing the mix. One type is mounted on a horizontal axis and turns end-over-end vertically. In another, the steel drum is mounted on the machine base so that it rotates at an angle of about 30° from the vertical. This machine is one of those equipped with baffles to intensify the mixing action. In still another tumbling unit, the drum is mounted at an angle to the horizontal shaft and is balanced by another drum at the opposite end of the shaft.

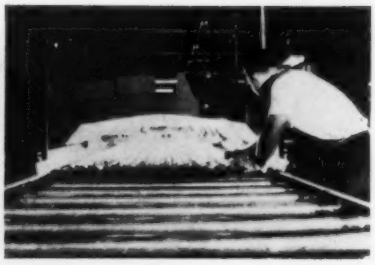
None of the tumbler containers have moving elements, although

Heat, Dry, Cure Plastics Faster...More Uniformly!



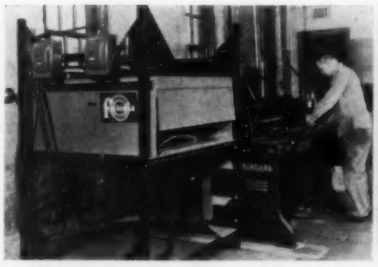
Above. Drying plastic granules in Fostoria oven prior to molding operation at Hungerford Plastics Corp., Rockaway, N. J.

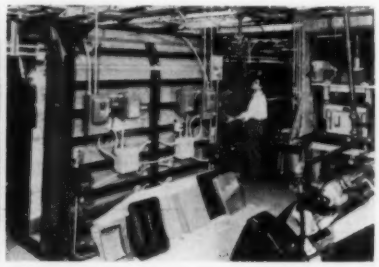
Below. Plastic sheets are preheated in a portable Fostoria oven before shearing and punching, at Tingstal Co., Chicago.



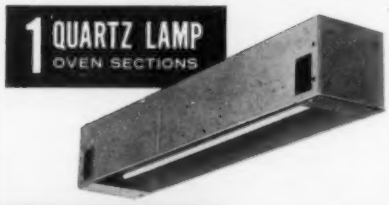
Above. Reinforced plastic sheets are shown being cured by Fostoria radiant heat, at the Resolite Corporation plant in Zelienople, Pa.

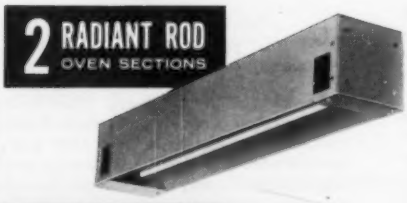
Below. Fostoria oven is used to preheat plastic sheets in 1½ minutes before forming operation at U. S. Rubber Co., Chicago, Ill.





Fostoria . . . *your one source of radiant equipment for all 3 sources of infrared energy!*







Select components or complete ovens!

When your processing must be swift, safe and sure . . . and exceptionally uniform preheating, drying and curing is essential . . . you'll do well to consult Fostoria first because you get an exclusive brand of heating know-how. Whether your operations call for near- or far-infrared heat your complete satisfaction is certain when you put Fostoria radiant equipment to work!

Consult your nearest Fostoria Sales Engineer. He'll help solve your heating problems better than any in the field! Or write direct for more detailed information. Dept. MP-57

fostoria INFRA-RED SYSTEM

FOSTORIA PRESSED STEEL CORPORATION Fostoria, Ohio

Pioneer Manufacturer of Radiant Equipment . . . Components to Complete Ovens

CARVER LAMINATING PRESS



. . . FOR PRODUCING

PLASTIC LAMINATED TAMPER-PROOF MOISTURE-PROOF Identification Cards and Badges Photographs, Important Papers . . . in sizes up to 9″x12″

Patented and Pats. Pending

Large material may be preserved by plastic laminating after being photostated or otherwise reduced.

PHOTOGRAPHS and records to be laminated are placed between two sheets of cellulose acetate or similar plastic, in stacks up to 6 layers, within the size of the platens. The layers are separated by polished plates. Each stack is accurately heated and cooled under controlled temperature and pressure.

The sheets are laminated and welded together with an impervious bond at the edges. Individual photos, cards of other laminated records are then trimmed on an ordinary photograph trimmer.

The press handles any of the standard or special plastic sheets suited to laminating.

No particular skill is required to produce up to 800 perfect laminations per 8 hr. day. The press is shipped ready for connection to standard electric outlet (110 volts A.C.) and cold water supply. No special wiring or plumbing required. 220 volts or D.C. if specified.

PROMPT SHIPMENT FROM STOCK

Carver Laminating Press (illustrated), Model 150, is available from stock. Polishing plates and blotters, 5″ x 6″ or 6″ x 6″, at slight additional cost. Cards, badges, and plastic materials may be purchased through regular suppliers.

Distributors

GRAFLEX INCORPORATED
ROCHESTER 8, N. Y.

FRED S. CARVER INC.
HYDRAULIC EQUIPMENT
5 CHATHAM ROAD SUMMIT, N.J.

some types do have curved baffles affixed to their internal walls to direct the material from one end of the barrel to the other as it is revolved.

A centrifugal-type mixer which was originally developed for use by food processors is suitable for blending batches of dry mixes. This machine has an enclosed motor which drives a directly-connected mixing rotor at high speed.

Ribbon blenders: Another type of premixer employing internal moving elements to effect the blending is a ribbon blender, which can be used with either wet or dry mixes. The mixing action is accomplished by several equally-spaced helical blades, rotating on a horizontal axis in an enclosed trough. The trough contains a top opening for feed purposes and a bottom port for discharge.

Plasticating equipment

After the initial premixing of the components of a molding compound in a blender, it is usually necessary that the mixture be worked into a soft (molten) state under heat and pressure. Among the intensive-type mixers suitable for plasticating are the Banbury, intermix, and spiral flow mixers, mill rolls, and extruding machines of various types.

Intensive internal mixers: These generally consist of a mixing chamber containing two revolving rotors. Clearance between the rotors and the wall of the chamber is small, assuring thorough mastication of the material between them. The material is charged into the chamber through a hopper. Generally, the mixer is equipped with a pressure ram which, when activated, forces the material into the rotors. Most mixers of this type are cored and jacketed for circulating a liquid heating medium.

Milling rolls: A set of milling rolls consists of two steel rolls, cored for the circulation of steam or other heating medium. The rolls are usually horizontal, parallel, and equidistant from the floor. They rotate slowly toward each other. The roll nearest the operator is known as the "mixing roll"; it turns slightly faster than

the other roll and is cooler. The space between the two rolls can be adjusted by the operator to exert the desired amount of pressure. Doctor blades attached to the rolls, or ordinary knives, can be used to cut the blanket of material adhering to the mixing roll so that it can be folded back for further mixing.

Multi-screw extruders: Twin-screw extruding machines are often used for compounding and coloring thermoplastic molding material. When used by injection molders, the material is generally extruded in the form of multiple rods or spaghetti which may be cut right at the face of the die, or may be conveyed through a cooling bath and thence into a pelletizer. When such a setup is used by extruders, however, it makes it possible to compound, color, and extrude into the desired section in a single operation. Two types of these multi-screw extruding machines are now being marketed in the U.S., one manufactured in this country and one in England.

In each machine, both worms participate in the kneading and heating operation, but in the American machine, the actual extrusion is effected by only one screw, the other one being shorter in length. In the British machine, the flights on the two screws are of the same pitch, permitting them to mesh, but in the American machine the worms do not mesh. The material is plasticated by the pressure and heat as it is forced against the heated cylinder wall by the revolving screw, and as it is advanced along the flights in the screw toward the front of the chamber. On both machines, the screws are machined with progressively finer flights, to handle the material as it becomes more thoroughly melted in the cylinder.

The size and shape of the cylinder chamber on each machine corresponds to the requirements of the screws. Thus, while both chambers are ∞ shaped at their feed end, the one in the American machine streamlines down into a conventional round shape at the discharge end, due to the fact that only one screw extends into the final section of the chamber. On

CARVER LABORATORY PRESS



Standard for Plastics Research Development and Control for More than Twenty Years

IN THOUSANDS of leading industrial firms, government and technological laboratories the Carver Laboratory Press is an indispensable aid in plastics research and development.

The Carver Laboratory Press, original in design, has long been accepted as standard for making quick, accurate small-scale tests; for development, research and instruction work; testing single cavity molds; preparation of samples, and even for small scale production. The Carver Press provides complete range of temperatures from room temperature to 400°F. Adjustable by thermo-switch to within plus or minus 2°F. Equipped with accurate 6" gauge, providing load readings up to 20,000 lbs. Low pressure gauges optional. Carver Standard Accessories include Electric or Steam Hot Plates; Electrically Heated and Water Cooled Hot Plates; Carver Test Cylinders; Swivel Bearing Plates; Cage Equipment, etc. The press and certain of the accessories are patented. Send for your free copy of our latest illustrated catalog, describing the Carver Press and some of its many applications.

GENERAL SPECIFICATIONS

Load	Platens	Opening	Stroke	Dimensions
0 to 10 tons (20,000 lbs.)	6" x 6" square	Adjustable 0 to 16" (7⅛" between Columns)	6½"	18" x 16" x 36"

FRED S. CARVER INC.
HYDRAULIC EQUIPMENT
5 CHATHAM ROAD SUMMIT, N. J.

Sealing Equipment
Hi-Frequency Generators

PACKAGING MACHINERY ERDCO HI-FREQUENCY EQUIPMENT

Production UP... Costs DOWN
with these high efficiency units



High frequency generator

Continuous duty high frequency generators with heavy duty, long-life components. Used for electronic heat sealing, forming and laminating presses, food and chemical processing, packaging, fast drying ovens. Power outputs up to 100 KW.

Combination press-generator units for low-cost, mass production plastic sealing.

Plastic Sealing Press . . . for stronger welds and higher output. Single or multiple electrodes — accurately aligned to .001" tolerance. Bed area 28" x36-48". Smaller or larger sizes available for your exact needs.

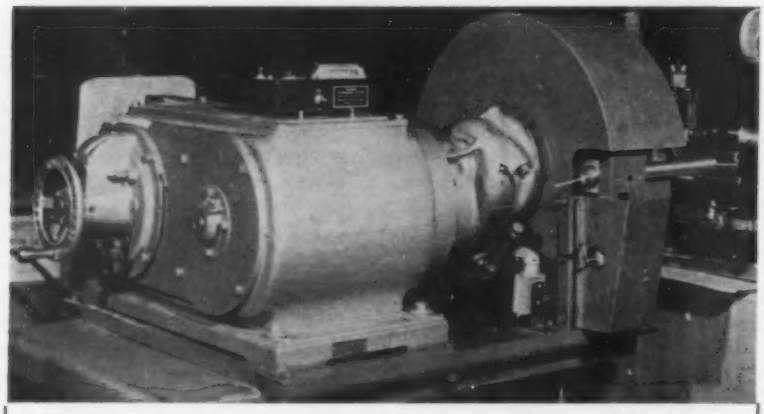
Clear-Pak Bubble Sealer . . . for high-speed show case packaging of hardware, soft goods, granular products.



Plastic sealing press

Send for new bulletins
ERDCO ENGINEERING CORPORATION
7452 Dept. MPE., Addison, Illinois

PACKAGING MACHINERY ERDCO HI-FREQUENCY EQUIPMENT



PRECISION EXTRUSION CUTTER

Capacity: Up to 2 in. diameter; tubes, rods, rectangles, shapes

Speed Range: 7080 cuts per minute to one cut in 6½ minutes

Cuts: Square and smooth, to close length tolerance

Knives: 1 to 8; variety of interchangeable blades for different cross-sections

FOSTER & ALLEN, INC.
628 South Avenue
Garwood, N. J.

Send samples for demonstration cuts with information about your requirements

the British machine, the ∞ shape persists throughout the chamber length.

Single-screw extruders: Some single-screw extruders, with worms especially designed to work the material thoroughly, are also used to compound and color thermoplastics.

Chopping, granulating, dicing

Theoretically, any crushing, grinding, or cutting equipment could be used for reducing thermoplastic compound to a size suitable for feeding into an injection machine or extruder hopper. In a specific case, the choice of cutting equipment will depend partly on the plasticating equipment that has been used and partly on the size and shape desired in the particles. Thus, compound coming in sheet-like form from mill rolls is usually broken mechanically, then fed first to a chopper where it is cut into large pieces, then to a granulator where the large pieces are converted into granules or powder. In contrast, rods of compound that come from an extruding machine are customarily cut by a pelletizer.

Choppers: The function of a chopping machine is to reduce continuous material, such as extrusions or sheets from mill rolls, to a size that can be conveniently handled by a granulator. The sturdy machine in which such rough, nonuniform cutting is accomplished is equipped with a series of rotating knives cutting against a bed knife. In fact, its operation is similar to that of a granulator.

Granulators: The machines used for final granulation of the material are generally grinders or dicers. Scrap grinders may be used for granulation of virgin stock. Materials manufacturers require heavier machines, of greater capacity, though built on a similar principle. Some of the heaviest granulators may obviate the preliminary use of a chopper.

The cutting chamber of a typical granulator consists of a motor-driven rotor containing revolving tool-steel knives which cut against fixed stationary knives that are set at a slight angle in the cheek pieces. The size and number of both rotary

knives and stationary knives will vary with the size and requirements of the machine. However, there is always an equal number of knives in each of the two cheeks. The bottom of the cutting chamber consists of a perforated screen. The size of the holes will determine the maximum size of the particles leaving the machine, which may vary from 5/16 in. down to a fine powder.

Whether a pelletizer or a dicer is selected will depend largely on the form in which the plastic is to be fed to it. Thus, the multiple rods emerging from a compounding extruder are already of the desired diameter, so the pelletizer merely needs to be capable of performing one operation—cutting the rod into the desired lengths. When the stock is to be cut hot, the pelletizing device, called a fly-knife cutter, may be located grazingly close to the face of the extrusion die, which feeds directly into it. The die face acts as one "blade" of the "scissor."

A typical fly-knife cutter consists of a single- or double-blade rotary cutter, mounted on a shaft that is turned by a small electric motor with variable-speed drive. In operation, as the cutter revolves, the blade or blades slice across the face of the die. Rate of extrusion, speed of revolution of pelletizer shaft, and number of blades will determine length of pellets.

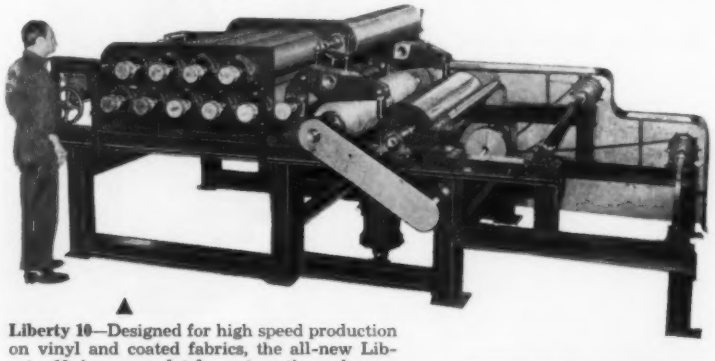
If the extruded rods or strips are to be cut cold, the pelletizer must be equipped with feed rolls to assure positive feed; constant rate is necessary if pellets are to be of equal lengths. The cutting blades revolve at right angles to the direction of feed.

When the stock to be pelletized comes to the machine either in the form of a sheet from milling rolls or wide strips from an extruder, the machine must be capable of cutting it both lengthwise and crosswise. Special dicing machines are made for this type of work; also available are slitting attachments for use on ordinary pelletizers. One machine, particularly suitable for cutting elastomeric materials but adaptable to rigid thermoplastics if they are fed warm, has a saw-tooth slitting roll instead of the feed roll

AT LOW COST
Liberty offers you high production film processing equipment

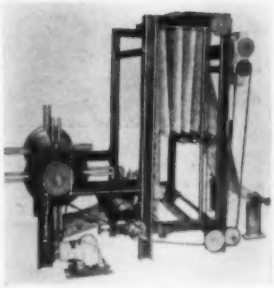
Here's a representative selection of Liberty machines. The *complete* Liberty line includes equipment for every step in film processing. And *every* Liberty unit gives you these advantages:

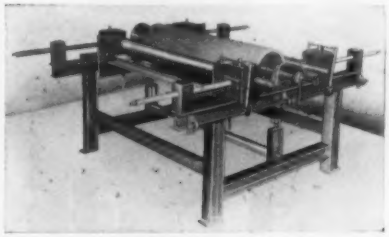
- **low initial cost**
- **rugged, designed-to-last construction**
- **easy operation**



▲ **Liberty 10**—Designed for high speed production on vinyl and coated fabrics, the all-new Liberty 10 is a completely automatic embosser. Ten electrically heated rollers permit speed up to 35 yds. per minute. And variable speed control assures proper rate of travel. Some basic design also available with 6 or 8 rollers.

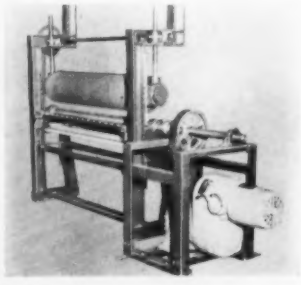
Liberty Batcher—Speeds production by minimizing delay at take-off, and eliminates wrinkles. Provides operator with 70 feet of material to work with. Turret can be used on back of any web processing machine. Precision guides insure straight rewinds. ▶





◀ **Liberty Two Color Printer**—Handles material from 48" to 72" wide. Exact registration assured by three simple roller adjustments. Has same easily operated type controls as Liberty one color printer.

Liberty Single Color Printer—Handles material from 48" to 72" wide. Construction gives clear view of both doctor blade and cylinder at all times. Quick roller change-over and work-up possible without removing rollers. ▶



Write for your free copy of Liberty's new catalog, and get the full details on the complete line of printers, J-boxes, polishing machines and embossers.

LIBERTY MACHINE CO., INC.

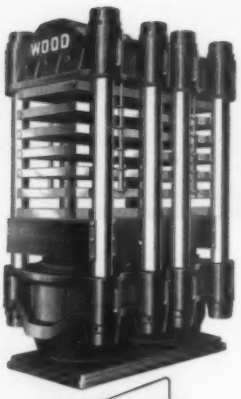
275 Fourth Avenue, Paterson 4, New Jersey • SHerwood 2-5565

special-purpose

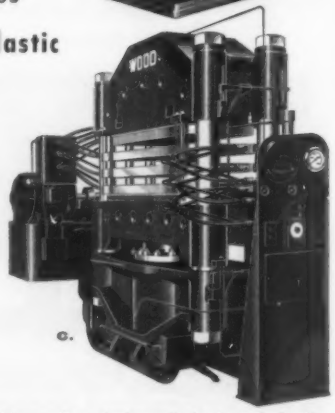
...R. D. WOOD

hydraulic presses

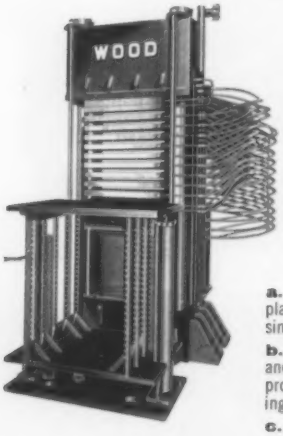
a full line of hydraulic presses and equipment for modern plastic product manufacturing



a.



c.

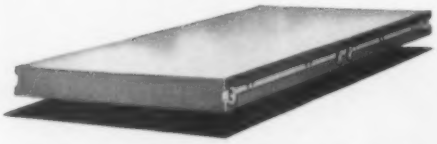


b.

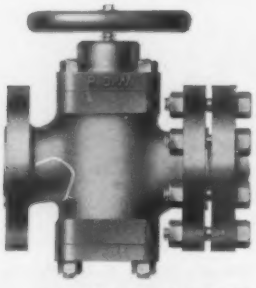
a. 1327-ton multiple-opening, duplex cylinder type hydraulic platen press for the manufacture of molded brake lining and similar products.

b. 880-ton multiple-opening platen press designed for polishing and laminating plastic sheets. The complete ten-opening sheet production unit includes a twenty-opening loading and unloading elevator.

c. 500-ton multiple-opening platen press designed for embossing and polishing operations in the plastics industries.



... heating platens in a wide range of sizes precision made for exacting work in the processing of all types of plastic products.



... a complete line of hydraulic valves especially designed for high pressure circuits.



... hydraulic power systems designed and built in all types of direct pumping hydraulic power units and pressure storing accumulator systems.

Write today for detailed information on R. D. Wood's full line of Hydraulic Presses and Equipment.

R. D. WOOD COMPANY

PUBLIC LEDGER BUILDING • PHILADELPHIA 5, PENNSYLVANIA

Representatives in Principal Cities

common to the rotary chopper which is used for pelletizing the rods.

For further information on colorants, see p. 367. Also consult the Subject Index. For sources of compounding equipment and colorants, see the Directory Index, p. 1018.

Recent Development

A new principle in the design of ball mills cuts milling time by as much as a factor of 10. In the new mills, four individual pots are arranged on the periphery of a circle that revolves around a central drive while each pot also rotates simultaneously on its own driving spindle. The result is a greatly multiplied mixing action and the subjection of a greater amount of the pigment (for example) and the liquid to the grinding action of the balls or pebbles. *Kinetic Dispersion Corp., 95 Botsford Pl., Buffalo 16, N. Y.*

EQUIPMENT FOR PREFORMING

Equipment for preforming is divided into two general classifications. One is the type used by a compression or transfer molder for producing dense pills or preforms from powdered or granulated molding material, or from impregnated chopped fabric thermosetting compounds. The second classification is used only by the molder of reinforced plastics, and its function is to produce a preform of chopped glass fibers in the approximate shape of the desired end product, this preform to be sufficiently strong to withstand handling without falling apart.

This article will treat with the first type of equipment. Preform machines for reinforced plastics molding are discussed on p. 523. Preform presses are discussed in the section below.

The chief function of a preform press is to compact loose plastic material into a dense shape that can be handled easily during preheating and mold loading operations. Preforms also assure uniform mold charges.

In addition to preforming, high-

speed cold molding can be accomplished on the preforming type of press. A floating head press is especially adaptable for this specialized operation, using a set of embossed dies.

Types of presses

There are two methods of classifying preform presses. One distinction is on the basis of single-stroke or rotary design, the other on the basis of mechanical or hydraulic operation. All types have variable-speed drives and a means for manually adjusting the weight and density of the preforms. On some of the machines, these adjustments can be made while the preform press is in operation.

Single-stroke presses may be operated by mechanical or hydraulic means or by a combination of the two. The mechanical type, which is the more common, may be actuated by a cam, toggle, crank, or eccentric mechanism.

The hydraulic type of press is less commonly used; a single-acting press of this type may be indicated for handling materials that cannot be fed automatically.

In general, in the standard automatic, mechanical single-stroke press, a volumetrically determined charge is fed into a stationary die cavity by a reciprocating or oscillating feed shoe. The hydraulic single-stroke press, on the other hand, is semi-automatic and the operator loads a measured charge into the die before the start of each pressing cycle.

To make preforms of a given contour on a single-stroke press, only a single die set is required. This will include a die block containing one or more cavities, and a corresponding number of upper and lower punch sets. A single-stroke press will deliver up to 60 preforms per minute. Although multiple punches can be used on this type of press, they are not in general use because of high initial cost.

Standard single-stroke presses apply the compacting load from one direction only. However, some special models compact from both directions, either by direct motion of both the opposing sets of punches, or by the use

FOR

molding, embossing, polishing, laminating . . .

PLASTIC



R. D. Wood Hydraulic Presses are designed to meet the many exacting demands of modern plastic product manufacturing.

Accurate and uniform heat-pressure distribution of R. D. Wood Presses provides high product uniformity under mass production conditions. Full production speeds and economies are assured by automatic and semi-automatic pressure controls, blow down, heating and cooling units; central and self-contained hydraulic systems; special platen arrangements and many other features.

R. D. Wood Presses are available in a wide range of models and capacities for many production requirements.

Before you buy, consult R. D. Wood Company. Write today for details of our full line of Hydraulic Presses and Equipment.

R. D. WOOD COMPANY

PUBLIC LEDGER BUILDING • PHILADELPHIA 5, PENNSYLVANIA

Representatives in Principal Cities



Makers of Hydraulic Presses and Valves | Fire Hydrants | Cast-Iron Pipe | Gate Valves | Gas Producers | Accumulators

WHITLOCK'S

THREE GREAT AIDS
In Handling Thermoplastic Material



Dryer

AUTOMATIC HOPPER LOADER

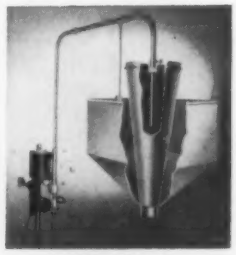
Transfers materials automatically from any container at floor level to hopper. Keeps materials at a constant level in the hopper, insuring a uniform supply to the heating cylinder.

HOPPER DRYER

Dries the material faster and more effectively, holding to a predetermined temperature. Proved successful on nylon, acrylic, butyrate and other materials where moisture is a problem.



Hopper Loader



Filter Cone Attachment

FILTER CONE ATTACHMENT

Handles dusty dry-colored materials. A conical shaped filter, which is filled automatically, extends down into throat of hopper, collecting the dust on the inner surface.

Write for Literature

C. H. WHITLOCK ASSOCIATES
21651 COOLIDGE HIGHWAY
OAK PARK 37, MICH.

TEMPERATURE CONTROL

keeps plastics production flowing freely

Call in a Powers engineer and you'll have fewer production headaches on your high-volume molding. He'll gladly help you in planning, and in specification of Powers temperature control equipment. He'll furnish service and maintenance instructions for your men — expert installation, too, if you wish. Prompt delivery from local stock. Seventy offices in the U. S. and Canada. Phone your local Powers office or write us today for a copy of "Temperature Control Reference Manual—Plastics Industry."



Final adjustments during installation of Powers Series 100 Indicating Controller (A) with remote sensing bulb, and Flowrite Valve (B) at Bell & Howell Co., Chicago. This equipment provides close control and proof-at-a-glance of compression molding die temperature. Result: more perfect parts per day—fewer rejects.

THE POWERS REGULATOR CO.
Skokie 34, Ill.

POWERS
PROCESS CONTROL

of a floating die, which is forced against the stationary set of punches by the motion of the opposing set of punches.

Other special models use hydraulic cushions to secure a slight dwell during the compacting operation. Such a dwell allows more time for the escape of air entrapped in the powder, and also permits the material to flow easily through complicated die areas.

Single-stroke presses are available in capacities of up to 200 tons; the largest size is capable of making preforms 28 sq. in. in area and weighing as much as 2½ lb. each at a speed of 45 or 50 per minute. A 75-ton press has satisfactorily produced ⅛-in. diameter preforms at the rate of 10,000 per min. in a 160-cavity die.

The single-stroke presses are particularly well-suited to the needs of molders who have a wide variety of preform requirements, because large and small preforms of various contours can be made with equal facility on the same machine, and because die changes can be accomplished with a minimum of downtime.

Rotary presses

Rotary presses are mechanically operated. They employ a number of die sets, mounted on rotating members. The material is compressed from both top and bottom, as the die cavity block and both the upper and lower punches of the die set move simultaneously between revolving wheels. Ejection of the preforms is accomplished by cam actuation of the lower punches.

As in the case of single-stroke presses, charges for the rotary presses are volumetrically determined. However, in the case of the rotary presses, the dies do not remain stationary for filling as they do on single-stroke presses. Instead, the cavity is filled by moving it underneath a stationary material feeder.

Even with single-cavity die sets, production on a rotary is fairly high. In a single revolution of the die table, one or two pills are produced per die set, and there may be as many as 33 of these die sets on the die table.

Rotary presses are available in

capacities up to 100 tons. The largest machine is capable of making 60 six-in.-sq. preforms per minute. Special presses designed to accommodate multiple-cavity die sets have turned out as many as 4000 preforms per minute.

Changing the die sets on a rotary press requires considerably more time than on a single-stroke press; however, molders find the rotary type of press to be economical for long production runs.

For the molder to select the particular model and size of press that will best serve his needs he must have a clear understanding of three interdependent groups of factors: 1) *production requirements;* 2) *material characteristics;* and 3) *press limitations.*

Production requirements

When the molder customarily produces a variety of end products in relatively small quantities, he will usually find a single-stroke press best-suited to his needs, since such a press can accommodate a great variety of sizes of preforms, and, in addition only one die per size is required, whereas for a rotary unit up to 33 die sets per different size and shape would be needed. The molder who specializes in volume production of parts that require preforms of the same size and shape, such as a mass producer of buttons, collapsible tube caps, and closures of other types, will require a rotary preformer. The higher cost of the die set tooling is justified in this case since it is amortized over many millions of preforms. Most custom molders find that they require both the rotary and single-stroke types of preformers, because of the diversity of products they manufacture.

Material characteristics

Uniformity of density, thickness, and weight of preforms will depend partly upon the uniformity with which the material is fed into the preform die cavity. This, in turn, depends partly upon the granulation, flow properties, and bulk factor of the plastic material being fed. Materials of different feed characteristics may demand the use of different types of presses.

Granulation: The granulation

CUSTOM DESIGNED & MANUFACTURED
CONTINUOUS PROCESS SYSTEMS

SURFACE COATING SYSTEMS
. . . . for fabrics, paper and films
High-production machines are available for the application of plastisols, hydrosols, organosols and other surface coatings to continuous web materials.

IMPREGNATING SYSTEMS
. . . . for fabrics and paper
Varnishes, latices, rubber solutions, etc., are saturated into continuous web materials for the manufacture of electrical tapes, conveyor belting, pressure-tight fabrics and the like.

ROLL AND KNIFE COATING MACHINES
Reverse roll, rotogravure, knife-over-roll, floating single- and double-knife coaters, or a combination of several machine types are furnished for installation in the customer's coating line.

EMBOSSING & LAMINATING SYSTEMS
Low- to high-pressure roll embosser or laminating units are available in single and dual head designs.

FIBER ORIENTING SYSTEMS
Complete orienting systems are available to improve tensile strength and reduce elongation in a variety of synthetic fibers.

EXPAND ALIGNER
Computreater

TECHNICAL DATA ON REQUEST

C. A. LITZLER CO., INC.
1817 BROOKPARK RD. CLEVELAND 9, OHIO CABLE "CALITZ"
EXPORT REPRESENTATIVE: GILLESPIE & CO. OF N. Y., 96 WALL ST. NEW YORK 5, N. Y.

PLASTICOR
THERMOPLASTIC INJECTION PRESS

Ideal for—
Experimental
Short Runs
Color Testing
Small Precision Parts
Novelty Items
Hobbiests
Small Gears
Nylon Bearings
Patterns for Castings
Optical Parts
Dental Laboratories
and Hundreds more



MODEL A-2

Power-Pak
Air Cylinder
Operates on
100-125 lbs. P.S.I
line pressure
¼ ounce capacity
Up to 225 cycles
per hour
Easily operated by
semi-skilled help
Operator changes
molds
Inexpensive to
operate

SIMPLOMATIC MFG. CO.
4416 West Chicago Avenue,
Chicago 51, Ill., U. S. A.

FOUR HELPFUL SERVICES



Standard Tool Company offers the plastics industry four lines of help to produce better plastic products at lower cost. If your interest is in molds or beryllium copper castings or injection molding machines or fabricating machines—Standard has the plant, the experience and the skills to help you.

Any and all of the leaflets illustrated are yours for the asking. Just drop us a note on your company stationery.

STANDARD TOOL COMPANY
203 Hamilton Street, Leominster, Massachusetts
OMNI PRODUCTS CORPORATION, Export Distributors, New York, N.Y.

of general-purpose materials do not usually raise any feed problem. The occasional slight segregation of particles by size within the cavity is usually not serious enough to warrant the use of special devices to control it. But when the material is in the form of a fine powder or contains a high percentage of fines, air entrapment may create a problem. This can be alleviated to some extent by increasing the clearance between die and punch or applying a vacuum to the die cavity. The slower-acting hydraulic type of press will allow more time for air escape than the mechanical type, if other performance considerations do not outweigh this particular advantage.

Bulk factor: The bulk factor of the material to be preformed is a very important determinant on the choice of the particular model of preforming press, for it influences both the type of feed arrangement required and the depth of fill necessary on the press for efficient performance.

On the basis of bulk factor alone, a quick choice may be made between standard machines and those designed to handle high bulk factor materials. Most standard machines are intended to handle general-purpose materials with bulk factors as high as three to one. When equipped with special rotary feeding devices, they can be used with materials having bulk factors as high as six to one. However, when the bulk factor is higher than that, special presses must be used. On the other hand, the type of machine designed to handle high bulk factor materials would be uneconomical for use with ordinary materials because of the additional expense factors which are involved.

The bulk factor not only affects the type of feed required on the press, but also may, in combination with preform thickness requirements, determine the depth of fill required on the press. For example, if a material with a bulk factor of two to one is to be used, and a 1-in.-thick preform be made, a press with a 2-in. maximum depth of fill can be used. However, if the bulk factor

of the material is four to one, this preforming machine will not be satisfactory, as the maximum preform thickness would be ½ inch. In this case, to produce a 1-in.-thick preform from the same material, a press with at least a 4-in. maximum depth of fill is needed.

Press limitations

Static pressure: The static limit of a machine is the amount of applied force which the machine will withstand without permanent deformation or damage.

Power limitation: The power limitation is a little more difficult to understand, because it depends upon the primary driving motor of the press, the inertia of the moving parts, and the speed of operation. Basically, it can be explained thus: In preforming, a definite expenditure of energy in the form of work is required to compact and eject a pill. This energy requirement varies with the depth of fill, the configuration of the die, the type of material used, and its condition. In addition to the work required to make the pill, an added amount of energy is used to deflect the stress portions of the machine and to overcome friction during the pelleting operation. The total energy must be supplied by the driving motor; otherwise, a degenerate cycle exists.

Die area: The die area limits the size of the die or the number of cavities that can be placed in a single die in the press.

Core rod placement: The limitation for the installation of core rods is a point not often considered in the selection of preform equipment. Yet it is a decided advantage to be able to produce core preforms for use in compression molding of certain types of pieces requiring many complicated die cavities.

Feed arrangements: The gravity-feed hoppers with which most standard machines are equipped provide satisfactorily uniform feed with most general-purpose materials. However, special auxiliary mechanisms, or even special presses, may be required with the high bulk factor materials.

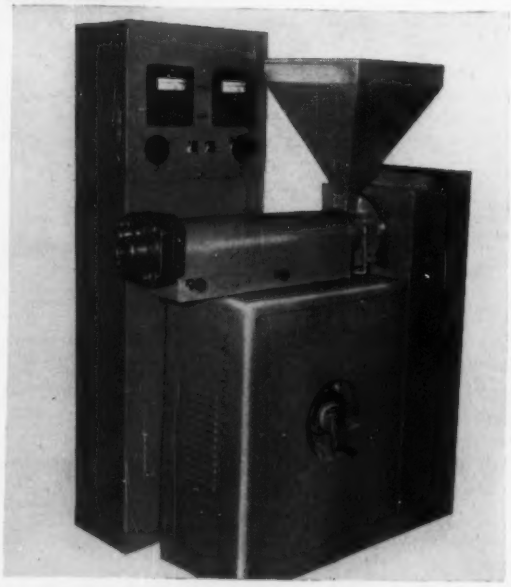
Vibrators are sometimes used

FOR EXTRUDERS... CALL KILLION ...THE SPECIALIST!

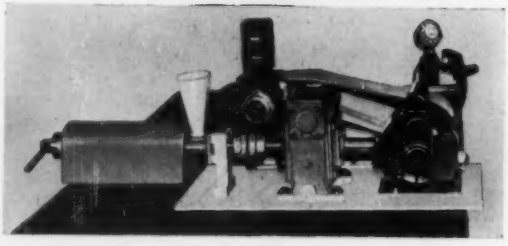
Killion "K" MODEL extruders are priced up to 28% lower than other leading makes, and there's a reason. Killion specializes! Killion produces extruders and extruder components . . . nothing else!

rugged...reliable...reasonable

K MODEL EXTRUDERS



1½" Extruder
Capacity: 35-50 lbs. Complete, as shown, less than $4,500.



¾" Laboratory Extruder
Used for film sealing. Complete, as shown, less than $500.

Compact and sturdily built. No fancy gadgets to increase prices. Only the best parts are used, including SKF Bearings, Xalloy-lined Barrels, U. S. Vari-Drives, etc. Every part of every size "K" MODEL . . . from ¾" to 4½" . . . is functional to give fast, precise production under rugged operating conditions.

for specifications and prices, write or call

KILLION TOOL & MANUFACTURING CO.
56 Depot Street, Verona, N. J. • Center 9-0200

to facilitate feeding of material that will not feed properly from standard gravity-type hoppers. A rotary type of brush feed mechanism is also available, for handling fluffy medium-impact materials having bulk factors of between 3:1 and 6:1. For high-impact materials containing rag or canvas filler, and having bulk factors as high as 16 to one, it is necessary that each preform charge be weighed, since no bulk measurement system will produce preforms which are sufficiently accurate in uniformity.

EQUIPMENT FOR HEAT-SEALING

Primary function of heat-sealing equipment is to supply sufficient heat and pressure to bond two or more heat-sealable surfaces together. Heat-sealable materials may be classed as those materials which melt or become fusible at temperatures generally ranging between 150 and 350° F. When two pieces of material of this type are pressed together and the contacting surfaces raised to the temperature at which the material melts, a weld can be made.

Heat-sealing equipment for thermoplastics materials are of two general types—one type uses electrical resistance elements to heat jaws, rollers, or metal bands; the other uses a high-frequency generator for the purpose of heating the material.

One of the recently developed processes makes possible the production of multi-colored rims and edges for three-dimensional appliques in a single heat-sealing operation. To accomplish this, a special die, built to the design of the required applique, not only heat-seals the applique, but also provides a tear-seal to the same design. Thus, after the applique has been bonded to the film being decorated, the operator merely strips the excess material, which tears smoothly and uniformly at the edges of the applique.

Resistance heat-sealers

Heat-sealing accomplished by means of electrical resistance elements requires a cooling of the seal under pressure to insure the bond strength for most plastics films.

Electrical resistance heat-sealers are of two general classes: the jaw type and the rotary sealer. The simplest is the jaw type in which two heated metal bars or platens are brought together by a mechanism operated either by hand or motor.

There are two types of rotary sealers. In one type, sealing is effected by passing the material between two heated motor-driven rolls. The second makes use of two thin endless metal bands which carry the material through both the heating and cooling zones while continuously applying pressure to the film. By permitting the accurate control of temperature, pressure, and time, the latter machines may be used for heat-sealing oriented films and those with a low heat dissipation factor, as well as the regular thermoplastics.

Both rotary- and jaw-type sealers usually have sealing members made of brass. Steel members are sometimes used because of better wearing qualities, but since the thermal conductivity of steel is low, this material is recommended only for automatic machines which handle films at fixed speeds. The fixed speed permits the adjustment of heat input to heat output. For semi-automatic machines, which are those guided by operators, attempts are made to feed the same number of units each minute since variations in feeding speeds induce variations in temperatures. Provisions for making pressure adjustments are necessary for both types.

High-frequency sealers

Electronic or high-frequency heat-sealing takes advantage of the electrical characteristics of many plastics materials. In this

RECENT DEVELOPMENTS

A heat-sealer that closely resembles an office desk combines a dielectric heating generator with a clam-type press. Areas up to 12 sq. in. and straight seals as long as 20 in. (45 in. on special order) may be sealed in one cycle. Cycles are automatically timed and the rated output may be either 2 or 3 kw. *Erdco Engineering Corp., Addison, Ill.*

A semi-automatic heat-sealer that seals unsupported plastics films (including polyethylene) and plastics-coated sheeting is the Model 54UL. It uses an electrically heated platen and a clamping pad faced with fibrous-glass-reinforced Teflon. *Product Packaging Engineering, 5747 Marilyn Ave., Culver City, Calif.*

Combining several pieces of equipment, a new process for fabricating plastic curtains is capable of turning out 1800 to 2000 units per day. A rotary sealer, drawing sheet from continuous rolls in widths up to 72 in., first side-hems the material, after which it is re-rolled. An 80-in. "thruway" press then attaches a clear, heavy-gage vinyl header, forms 12 grommets with tear centers, and bottom-hems the curtain. *Mayflower Electronic Devices, Inc., Little Ferry, N. J.*

Electronic sealers with outputs of 0.5, 1, 3, and 5 kw. can handle a wide variety of seal patterns. The top of the generator housing is designed to be used as a work table, and the controls and indicating meters are all set into a convenient sloping panel at the rear edge of the table. *Raybond Electronics Inc., 66 Needham St., Newton Highlands 61, Mass.*

A heat-sealing machine (U. S. Pat. No. 2,747,646) combines radiant heating with dielectric heating to make possible two- or three-color tear-sealing of appliqués on vinyl sheet. Under certain conditions more than three colors can be used. General characteristics are: Power input: 40 amp. at 220 v., single phase, RF output: 3 kw. *Cosmos Electronic Machine Corp., 656 Broadway, New York 12, N. Y.*

Recent Developments were excerpted by the editors from MODERN PLASTICS, Oct. 1956 through July 1957.

method, the heat for sealing is generated inside the material by the passage of high-frequency electric currents through it. Since only the inner surfaces of the film soften, no cooling zone is required, so that cooling and bonding are almost instantaneous.

There are three basic parts to an electronic sealer: the oscillator or high-frequency generator; the mechanism for applying pressure, such as a press or a frame for mounting rollers; and the electrodes. The high-frequency generator is in principle a radio transmitter with its output side connected to the electrodes of the sealer instead of to a transmitting antenna. Most oscillators are tuned to 27.12 ± 0.16 mc., one of the three frequencies assigned by the Federal Communications Commission, although well-shielded oscillators may operate at any frequency.

Prefabricated shielded rooms of various sizes have recently been made available in kit form for shielding oscillators which do not operate at the required FCC frequency. These rooms have copper or bronze screens and leakproof doors and air intakes.

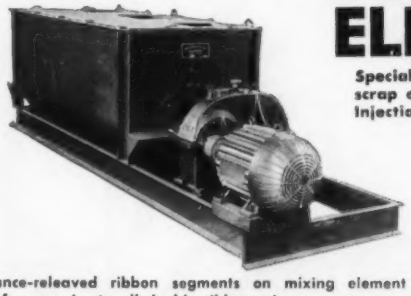
In bar or "one-shot" sealing the electrodes are shaped to the profile desired in the bond. In some instances the electrodes may be machined dies with one placed in the upper and one in the lower section of the press. In one widely used setup, a single set of formed electrodes in the upper portion of the press seals at all points of pressure against a flat plate electrode in the lower portion of the press. The problems of special dies are eliminated in some machines by the use of a brass strip which can be adjusted to produce any shape of seal.

In continuous sealers, the electrodes may be machine-driven rollers which not only transmit the high-frequency energy but also act as a feed for the film passing between them. While some continuous sealers are large units, most are of the sewing-machine type. Another variation of the continuous sewing-machine-type sealer makes use of very small bar electrodes. The rapid clamp action of these mechanically operated bars pulls mate-

Buy **Bailey** . . . For the **Best** in Plastics Equipment

Improved Pre-Plasticizing

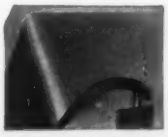
BAILEY BLENDER ELEMENT



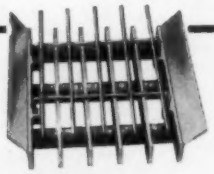
Specially developed for mixing vinyl scrap or virgin plastics.
Injection Molding
Extruding
Calendering

Clearance-releaved ribbon segments on mixing element prove far superior to all double ribbon mixers.

- Increases blending efficiency, makes a *better* mix *quicker*.
- More thorough emptying of blender—faster cleanup.
- Reduces maintenance costs.



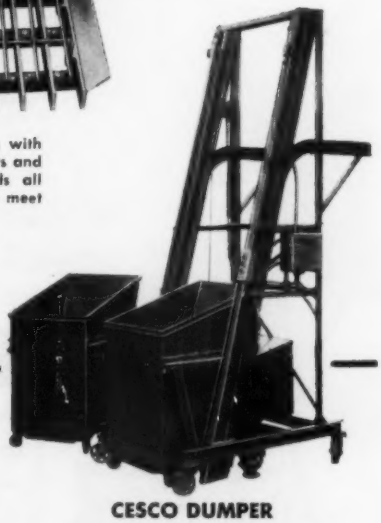
ROUNDED CORNERS
for quicker, more complete cleaning—no contamination between batches.



MAGNETIC GRATE SEPARATORS

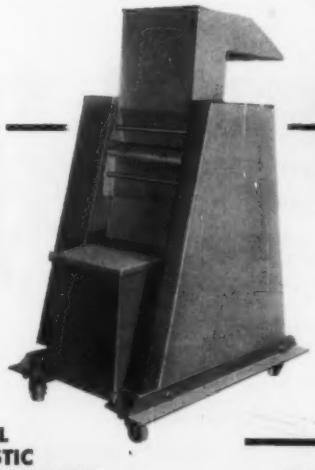
Prevent Costly Damage

Highly saturated Alinico No. 6 magnets with steel intervening bars for extruder hoppers and granulator discharge. Attracts and holds all ferrous objects. Stock or special sizes to meet every requirement.



CESCO DUMPER

Portable Banbury or extruder loader with quick-cleaning, stainless steel batch buggies. Ideal for loading pre-blended materials or materials of different colors. Extra buggies available —dumper can be used with bags, barrels and drums as well.



IDEAL PLASTIC GRANULATOR

Grinds polyethylene and vinyl without fluffing—no fly backs or leakage. Rotary and stationary knife combinations made of special high speed tool steel wear longer with minimum resharpening. Extra large removable bin and cover. Ten sturdy, all-steel models to choose from—all adaptable to specific purposes: air take-off systems, roll feeds, wider throat openings.

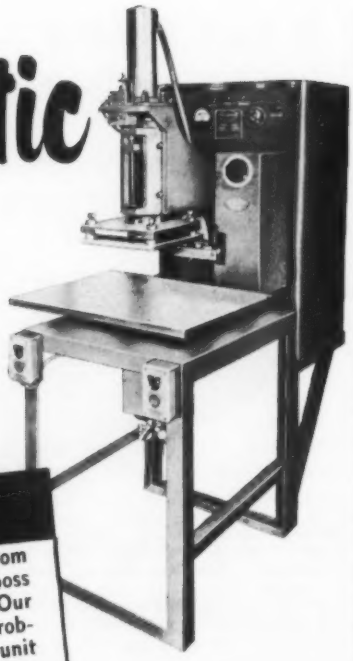
Write for complete details on these and other mixing, grinding, elevator, and sifting equipment.

R. N. BAILEY & CO., INC.

11 West 42nd St. New York 18, N. Y.

Sealomatic

ELECTRONIC HEAT SEALING MACHINES FOR EVERY PURPOSE

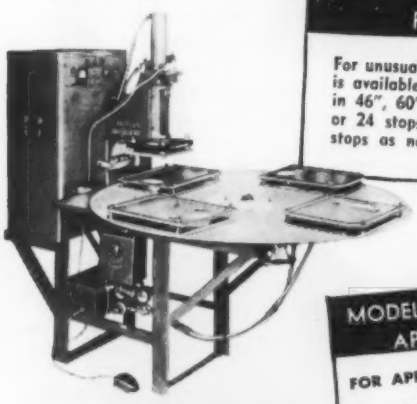


SEALERS FOR EVERY POWER REQUIREMENT

Sealomatic makes standard models from ½KW up to 30KW to weld, cut, emboss flexible or rigid plastic products. Our engineers will analyze your sealing problem and can recommend the stock unit or units that best meet your needs.

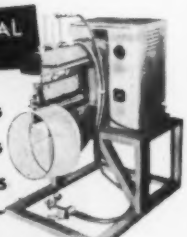
TURNTABLE UNITS FOR AUTOMATION

For unusual speed and flexibility, a turntable unit is available with all Sealomatic sealers, available in 46", 60" and 72" diameters, with 4, 6, 8, 12 or 24 stops per revolution. Other diameters and stops as needed.

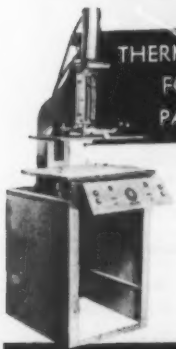


MODELS FOR SPECIAL APPLICATIONS

FOR APPLIQUE— 3D SEALING
FOR LAMPSHADE SEALING
FOR AUTOMATIC FEEDING FROM ROLLS



THERMAL UNITS FOR BLISTER PACKAGING



CUSTOM BUILT UNITS TO YOUR SPECIFICATIONS

Sealomatic's long experience in the field and extensive facilities enables us to design and build any model to meet the most rigid requirements.

COMPLETE FIELD SERVICE FACILITIES
WRITE OR PHONE FOR BROCHURE
AND FULL DATA ON ALL MACHINES

SEALOMATIC ELECTRONICS CORPORATION

Dept. E - 429 KENT AVENUE • BROOKLYN 11, N. Y.
EVergreen 8-9413

rials forward at each stroke. The forward movement of the material results in an overlap at each point of weld. It is possible to bond practically any desired seam by use of the sewing-machine-type sealer. Needle trade operators can also rapidly learn to use this type.

EQUIPMENT FOR REINFORCED PLASTICS

Because of the different methods used to produce molded reinforced plastics parts, the equipment that is required is necessarily varied.

For simple bag molded parts, the equipment need include only a mold, a flexible bag, a vacuum pump, and an oven or a bank of infra-red lamps. However, when producing large parts in matched metal molds, the required equipment will include many complex items such as air or hydraulic presses having a large platen area and adjustable daylight as well as long and fast ram travel; timers and controls; special machines for making preforms from chopped fibrous glass rovings; curing ovens; and materials handling equipment. The latter conveys preforms to the oven and then to the press as well as transports the molded parts to finishing and shipping stations.

For high-speed production of noncontinuous reinforced plastics sheet, the major items include a coating device equipped with squeeze rolls or some other resin metering device, numerous highly polished steel caul plates, a multiplaten press, and a large shear for trimming the edges after molding.

Continuous sheet may be produced with paper, fibrous glass, or other suitable reinforcement, using a "nonpressure" curing resin as the binder. By this method, one or more rolls of web are mounted so that they can be fed through an impregnating tank or under a sprinkler-type of resin applicator, and then to a set of combining rolls which also serve to squeeze out the excess resin. These rolls are fitted with end gates which keep excess resin from flowing out at the edges. Such gates are adjustable for width of web. As the individual

webs combine, "carrier" webs of cellophane or coated paper fed from nearby let-off rolls join the assembly as top and bottom surface coverings. Carrier webs are usually 4 to 6 in. wider than the laminate.

The feed of the carrier web is controlled by brakes and side adjustments. The curing section is usually a textile tenter frame, or a modification thereof, which carries the laminate through the ovens. Ovens are 50 to 100 ft. long and are zoned into three to five sections where preheating, curing, and after-heating take place.

Wind-up rolls

Carrier sheet removal is accomplished by wind-up rolls, suitably clutched. The cured laminate is then trimmed at the sides by saws or rotary shears. Cut-off into desired sheet length is done with electric sheet-metal shear equipment. The shear must be properly maintained; a poorly adjusted or dull shear will cause delamination.

Sanding the back of the laminate is necessary in order to provide good adhesion. Special sanders are available which perform this operation uniformly and quickly.

For all types of molding, except that in which pre-impregnated stock is used, it is necessary to have weighing and mixing equipment for the preparation of resin.

All reinforced plastics parts require grinders or sanders for flash removal and many items require edges smoothed by buffing.

For a complete discussion of the various types of preforming equipment which are available, see p. 523.

References

For further information on reinforced plastics materials, see chapters listed on p. 506, as well as the Low-Pressure Laminating Resins Chart. Also consult the Subject Index, and the Directory Index, p. 1018.

"Reinforced molding compounds," MODERN PLASTICS *31*, 12 (Aug. 1954).

"New tools, new plant for car bodies," MODERN PLASTICS *31*, 115 (Aug. 1954).

"Custom Built for Plastics"

Gardsman TUBELESS* TEMPERATURE-CONTROLLERS



Model JP Series
PROPORTIONING Controllers

This time-proved unit is widely used for closer control than the basic On-Off system permits. JP *anticipates* temperature changes, tends to stabilize the system to desired temperature, makes new harder-to-mold materials a simple production job.

Model JPT Series
3-POSITION Proportioning Controllers

Designed especially for plastic extruding and injection molding machines, to control heating of barrel or cylinder, and cooling with either air or water. Ideal for high-friction materials like Rigid Vinyl. Provides Model JP Proportioning Control of heaters *plus* automatic control of cooling cycle *only* in case of overshoot caused by heat of friction or temporary shut down. Avoids heat-waste and decomposition of plastic materials.





Model JS Series
STEPLESS Controllers

Closest practicable control, virtually eliminates temperature variable. Constantly modulates input to demand. Prolongs heater life by reducing thermal shock. No tubes, no relays. Multi-load units, adjustable control-band width, manual reset. Simplest operation: one knob.

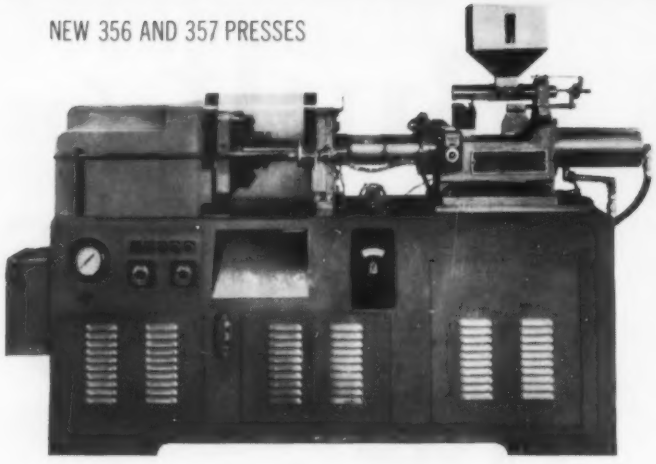
**Minimum maintenance. No need for "tuning" to suit tube-ageing. Reliable — Guaranteed — AND these Gardsman Controllers save on original cost! Specify model series in writing for data.*

4359 W. Montrose Ave.
Chicago 41, Illinois

WEST Instrument CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

HYDRAULIC PRESSES

NEW 356 AND 357 PRESSES



WITH MORE *Plus* FEATURES!

CAPACITY: 2¾ oz. at single stroke of plunger; up to 5 oz. with pre-packing

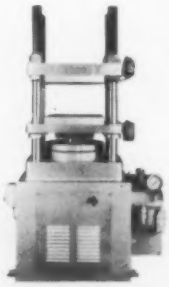
HIGH SPEED: Plasticizes up to 30 lbs. of material per hour

VOLUMETRIC FEEDER: For accurate material delivery to plunger

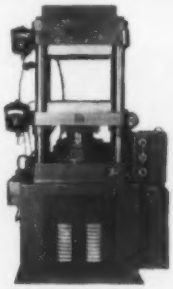
ADDITIONAL FEATURES: Up to 12" x 12" mold; heavy duty toggle clamp; up to 15 oz. heating chamber capacity; chrome plated cylinder; push button controls; thermostatic heating cylinder control; movable die plate for purging to change material or color.

Versatile presses with power plants designed to develop injection pressures up to 20,000 lbs. PSI. Will handle almost any molding material. Low initial cost, combined with high capacity, automatic operation and low operating costs, rate the 356 series as the "Best Buy" in modern injection equipment. Increased production lowers unit costs and that means higher profits. Model 356 rated at 20,000 lbs. PSI; Model 356A at 10,000 lbs. PSI.

Try Them For Performance—Buy Them For Profits!



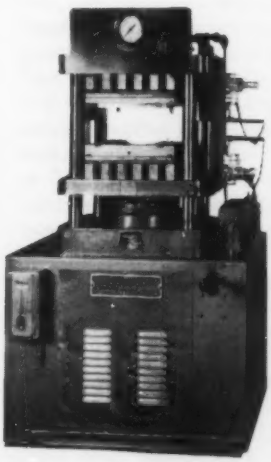
Molding Press
Adjustable Head



Automatic Mold Press
with de-gas cycle



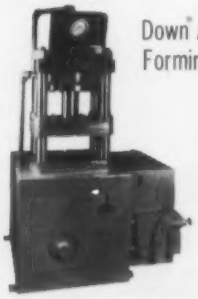
Hobbing Press



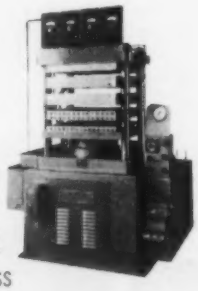
Plastic Molding Press

50	75	100	200	300 Tons
16x16	18x18	20x20	28x28	36x36

Steam or electric platens; power return



Down Acting
Forming Press

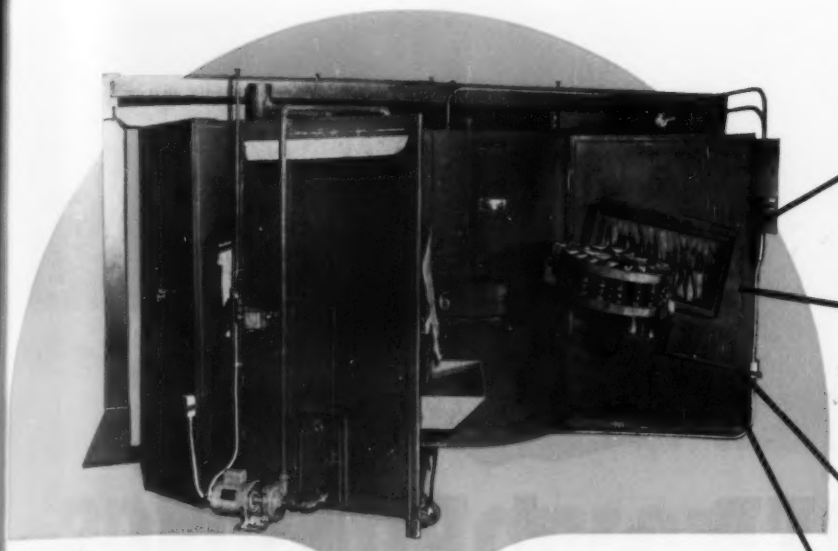


Semi-Automatic
Laminating Press

CLIFTON HYDRAULIC PRESS CO.

A GREAT NAME IN HYDRAULICS

289-E ALLWOOD ROAD CLIFTON, N.J.











MOLDING MAGIC!

MOLD UP TO 1620 BIG PROFIT ITEMS PER HOUR . . . LIKE MAGIC

PRESTO . . . PRODUCTION and PROFITS!

Yes, it seems like magic the way this machine converts raw material into finished goods, in one continuous operation. With only one man at the controls, polyvinyl chloride plastisols are automatically dispensed and rotationally molded to shape, completely controlled by the automatic features of the machine. The operator need not be a technician, because all the plastisols are scientifically prepared, using all the technological advances made by the nation's foremost companies. Now, any hollow article can be molded from polyvinyl chloride plastisols, thus creating countless new product possibilities. With a high hourly production and a low hourly cost, it naturally follows that units produced on this machine are BIG PROFIT items.

LET US SHOW YOU HOW TO DO IT!

We want to demonstrate our "magic" to you. Visit our plant and let us mold YOUR PRODUCTS, right before YOUR EYES . . . like "magic".

Write or call for detailed data or an appointment.

NOW . . . even BIGGER!

Machines are now available with a 15", 25" and 75" molding area, able to mold items *eight times larger* than previously thought possible. Items such as the unicorn, shown here. Imagine, it's automatically molded, in one operation!



THE AKRON PRESFORM MOLD CO.

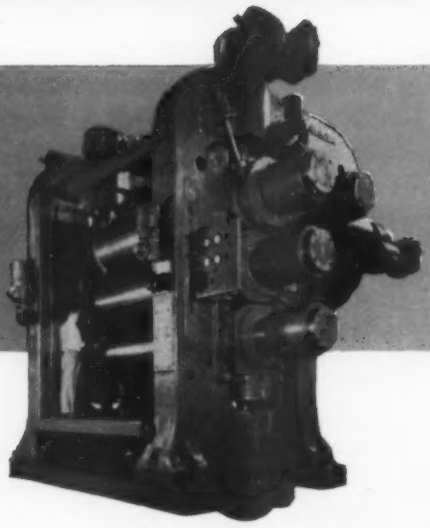
Phone WA 8-2105

2044 Main Street, Cuyahoga Falls, Ohio

FORMS	MOLDS	DIES	MACHINERY
LATEX DIPPING	STEEL AND ALUMINUM	PLASTIC INJECTION	SPECIAL AUTOMATIC

CALENDERS

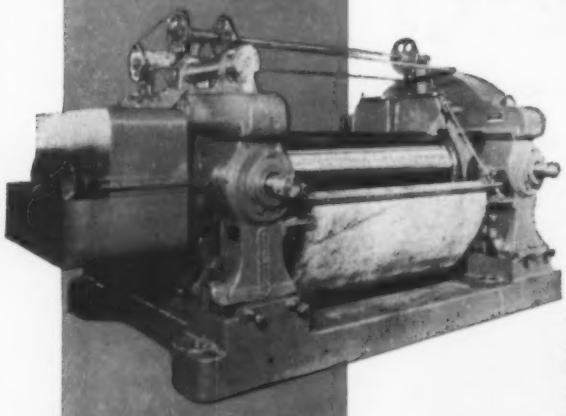
We make all types and sizes of Calenders, precision designed for extremely close tolerances to meet the most exacting requirements in the production of plastics film or the coating of fabrics with rubber or plastics. The unit shown is an ADAMSON UNITED 32" x 92", 4-Roll Plastics Calender geared to produce 72" wide vinyl film, 2 mils. or less in thickness at speeds to 150 YPM.



RUBBER and PLASTICS

... designed and built by...

We engineer and build all types of individual production units and complete electronically controlled trains with all accessories for every Rubber or Plastics processing requirement. Our highly specialized engineering and production facilities plus the combined research and technical abilities of United Engineering and Foundry Company, and the manufacturing capacity of eight modern plants, are at your service.

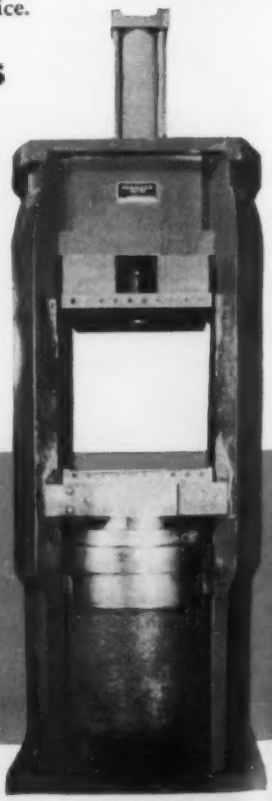


MILLS

An 84" Individual Mill equipped with a mixing apron. ADAMSON UNITED Mills may be had in all sizes from 6" x 16" to 28" x 84", driven individually; in pairs with right angle reducer between the units, or grouped on a line shaft with reducer at one end of the shaft. Apron, as shown, can be installed on any type of existing mill.

PRESSES

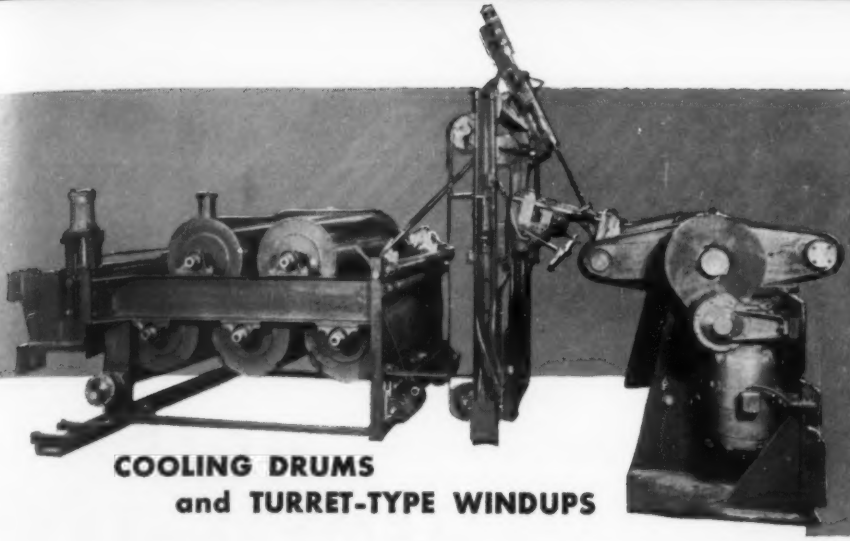
We build all types of presses for the rubber, plastics and plywood industries. Shown is a new 24" ADAMSON UNITED BARREL TYPE PRESS with transfer cylinder. This new press, an exclusive ADAMSON UNITED development, exerts up to 76% more platen pressure than conventional types without change in present hydraulic lines. Stock is transferred into the mold cavities through sprues which reduces cure time and flash trimming to a minimum. Sizes range from 12" through 32" with larger sizes available to specification.





AUTOCLAVES or VULCANIZERS

Built to specific requirements from 18 inches to 15 feet in diameter, any length, vertical or horizontal to withstand internal pressures as high as 1000 lbs.-per-square-inch. The Pot Heater shown is a vertical, cylinder-operated breech-door type.



COOLING DRUMS
and TURRET-TYPE WINDUPS

This is a standard type of accessory equipment arrangement for plastics film. It consists of embossing equipment; cooling unit; slitting devices; compensator stand and automatic turret windup. The turret windup stand is a center-drive-type with automatic indexing equipment, yardage counter, and adjustable tension control. We design and build entire calendering process systems including all accessory equipment.

— PRODUCTION UNITS

.....ADAMSON UNITED

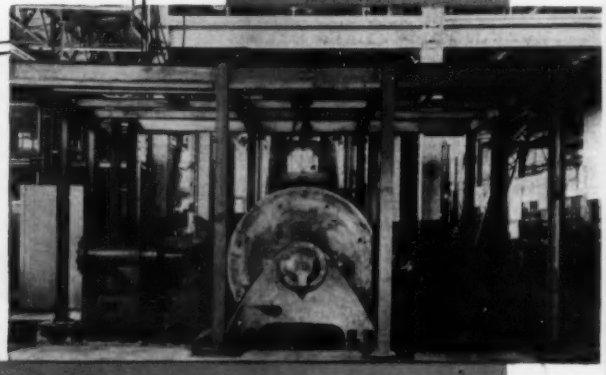
BRAKE and TIRE TESTING MACHINES

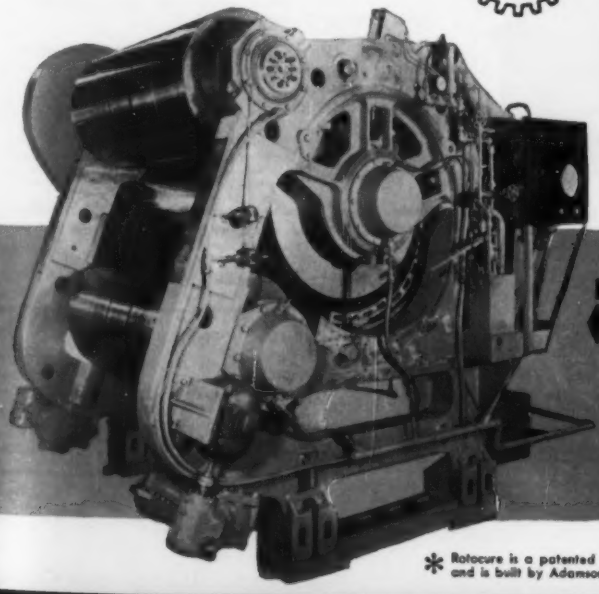
Installation shows an 84" Adamson United High-Speed Jet Airplane Brake and Tire Testing Machine of the inertia type. We have built similar machines as large as 16 feet in diameter for speeds up to 250 M.P.H. and tire loads to 150,000 pounds.

Wire, phone or write us today. No obligation.

ADAMSON UNITED COMPANY
730 CARROL STREET • AKRON 4, OHIO

SALES OFFICES IN PRINCIPAL CITIES
Subsidiary of United Engineering and Foundry Company





ROTOCURE*

A new machine for the continuous curing of all flat rubber or plastics articles with smooth or designed surfaces. Rotocure increases production through continuous operation without opening, cooling, reheating and closing. It eliminates overcuring or undercuring of the over-lap areas occurring on conventional presses. Roll and belt changes, incident to design requirements, can be made on this new 60" x 80" Rotocure in one-tenth the time formerly required.

* Rotocure is a patented development of Boston Woven Hose and Rubber Co. and is built by Adamson United Co. under a licensing arrangement.

THERMOLATOR

REG. U.S. PAT. OFF.

The Best Is Your Best Buy!



(a)

MOLD TEMPERATURE CONTROL

Is the original system of controlling mold faces at optimum temperatures by high velocity circulation of water, at precisely controlled temperature, through the channels in the mold.

Pays Off in . . .

Increased Production Speeds—Many users say 100% increase over over use of cold water in molds.

Lower Rejects—Molders experience marked reductions in scrap, with important savings as a result.

Improved Casting Quality—Surface quality improves; strains reduced; sinks minimized; dimensional accuracy improved.

Start Up and Trial Shortened—Because molds can be brought quickly to optimum temperatures, and held precisely, start up and trial times are all reduced.



(b)



(c)

Models For Every Need

(a) Model "H" Automatic THERMOLATOR—Control panel shown. For location alongside existing press control panel. Pyrometer Scales and Pilot Lights provide instant check.

(b) Model "H" Automatic THERMOLATOR with Controls Integrated in Master Control Panel—All press and mold controls in central location, built in master panel by instrument manufacturer.

(c) Model "C"—The original THERMOLATOR with semi-automatic controls. Holds mold temperatures in range of ½°-F. up to 250° or 600°.

Write us for literature, and our technical bulletin "Control of Mold Temperature," sent Free on request.

FOR INFORMATION WRITE TO . . .

Industrial MFG. CORP.

Specialists in Industrial Heat Transfer by Liquids

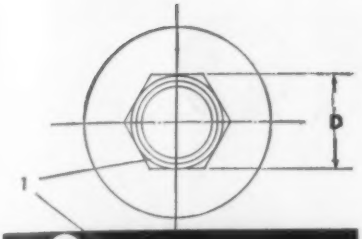
31 E. GEORGIA ST. · INDIANAPOLIS 4, IND.

REPRESENTATIVES

Plastic Molders Engineering Co., 55 E. Washington St., Chicago, Ill.; Scott Engineering Corp., 18985 Wyoming Rd., Detroit, Mich.; IN CANADA: Richardson Agencies, Ltd., 18 Holly St., Toronto 17, Ont.; FOR EUROPE: Metac, Inc., 44 La Boetie, Paris (8E), France.

MARVEL Synclinal FILTERS

For Hydraulic Oils, Fire-Resistant Fluids, Coolants, Lubricants and Water

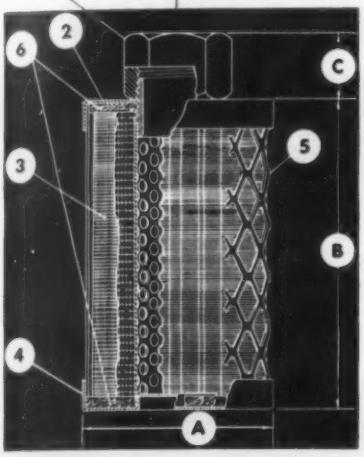


For either sump or line installation on all hydraulic and other low pressure circulating systems.

Both types are easily disassembled, thoroughly cleaned and reassembled in a matter of minutes. Line type operates at full efficiency in any position and may be serviced without disturbing pipe connections.

Choice of OVER 750 O. E. M.'s as Standard Equipment

MEET J. I. C. STANDARDS



SUMP TYPE

SUMP TYPE ENGINEERING DATA

Model	Pipe Size	G.P.M.	Mesh	Element	Pressure Drop P.S.I.	Oil	Temp. °F	Approx. Weight, Lbs.
S-¼-5	⅜"	5	100*	Monel	.187	225SSU	100°	1
S-½-8	⅜"	8	100*	Monel	.281	225SSU	100°	1½
C-1-10	1"	10	100*	Monel	.187	225SSU	100°	1½
S-1¼-30	1¼"	20	100*	Monel	.140	225SSU	100°	2½
A-1½-30	1½"	30	100*	Monel	.140	225SSU	100°	3
A-1½-50	1½"	50	100*	Monel	.343	225SSU	100°	3
A-2-50	2"	50	100*	Monel	.109	225SSU	100°	4
A-2½-75	2½"	75	100*	Monel	.093	225SSU	100°	4½
A-3-100	3"	100	100*	Monel	.078	225SSU	100°	5½

*Standard Mesh (other available mesh sizes range from coarse 30 to fine 200)

SUMP TYPE DIMENSIONAL CHART

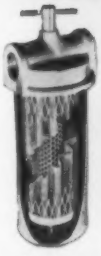
Model	A	B	C	D
S-¼-5	2¾"	4½"	1"	1⅝"
D-½-8	2¾"	6½"	1"	1⅝"
C-1-10	3⅛"	6½"	1⅛"	1⅝"
S-1¼-30	4⅛"	8½"	1⅛"	2"
A-1½-30	4⅝"	8½"	1⅛"	2⅛"
A-1½-50	4⅝"	8½"	1⅛"	2⅛"
A-2-50	5⅛"	9½"	1⅛"	3"
A-2½-75	6"	10½"	2"	3⅜"
A-3-100	6½"	11½"	2"	3⅛"



Sump Type (Cutaway)

PARTS LIST

1. Coupling
2. Top Cover
3. Reinforced Synclinal Insert
4. Base and Perforated Centering Tube
5. Expanded Metal Protective Housing
6. Neoprene Washers (Top and Bottom)



Line Type (Cutaway)

LINE TYPE

LINE TYPE ENGINEERING DATA (**)

Model	Pipe Size	G.P.M.	Mesh	Element	Pressure Drop P.S.I.	Oil	Temp. °F	Approx. Weight, Lbs.
SLS-½-5	½"	5	100*	Monel	.218	225SSU	100°	6
SLD-½-8	½"	8	100*	Monel	.375	225SSU	100°	7
SLC-1-10	1"	10	100*	Monel	.406	225SSU	100°	8
SLB-1¼-30	1¼"	20	100*	Monel	.312	225SSU	100°	12½
SLA-1½-30	1½"	30	100*	Monel	.312	225SSU	100°	14
SLA-2-50	2"	50	100*	Monel	.593	225SSU	100°	14

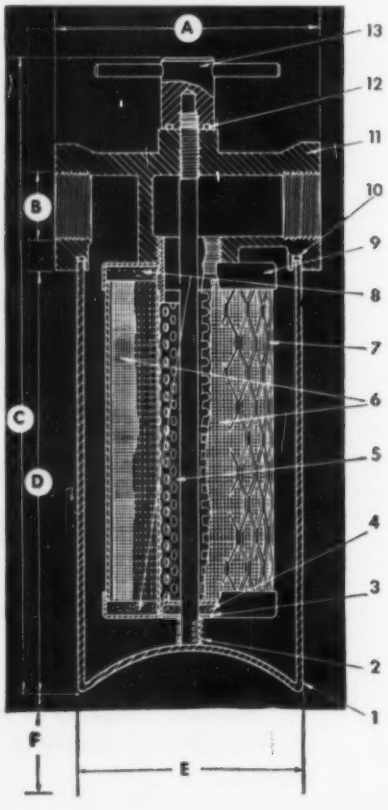
*Standard Mesh (other available mesh sizes range from coarse 30 to fine 200)

All Line Type Units Are Designed For A Maximum Working Pressure Of 80# Gauge.

LINE TYPE DIMENSIONAL CHART (**)

Model	A	B	C	D	E	F*
SLS-¼-5	5"	⅜"	8⅜"	4⅛"	4⅛"	7⅛"
SLD-½-8	5"	⅜"	10⅛"	6⅛"	4⅛"	9⅛"
SLC-1-10	5"	1"	11⅜"	7⅛"	4⅛"	10⅛"
SLB-1¼-30	5⅛"	1⅛"	14⅛"	10⅛"	5⅛"	13⅜"
SLA-1½-30	6⅛"	1½"	14⅛"	10⅛"	6"	13⅜"
SLA-2-50	6⅛"	2"	14⅛"	10⅛"	6"	13⅜"

*Since Marvel Synclinal Line Type Filters can be set in any position, this clearance space need not be below the filter. If the filter is placed upward instead of downward, then the clearance space would be needed at the top. Likewise, if the filter is placed horizontally or at any other angle, clearance space will be needed accordingly.



PARTS LIST

1. Outer Housing
2. Tension Spring
3. Metal Washer
4. Neoprene Gasket
5. Perforated Centering Tube and Base
6. Reinforced Synclinal Insert
7. Expanded Metal Protective Housing
8. Neoprene Washers (Top and Bottom)
9. Top Cover
10. "O" Ring (Large)—For Head Casting
11. Head Casting
12. "O" Ring (Small)—For Hand Nut
13. Hand Nut

(**) 75 and 100 G.P.M. capacity Line Type Filters also available. See catalogs for Dimensional Charts and Engineering Data.

Catalogs Containing Complete Data Available on Request

Catalog #108—For Hydraulic Oils—Coolants—Lubricants
Catalog #200—For Fire-Resistant Hydraulic Fluids (Aqueous base)
Catalog #400—For Fire-Resistant Hydraulic Fluids (Synthetic)
Catalog #301—For Water

MARVEL ENGINEERING COMPANY

7227 N. Hamlin Ave., Chicago 45, Ill. PHONE: Juniper 8-6023

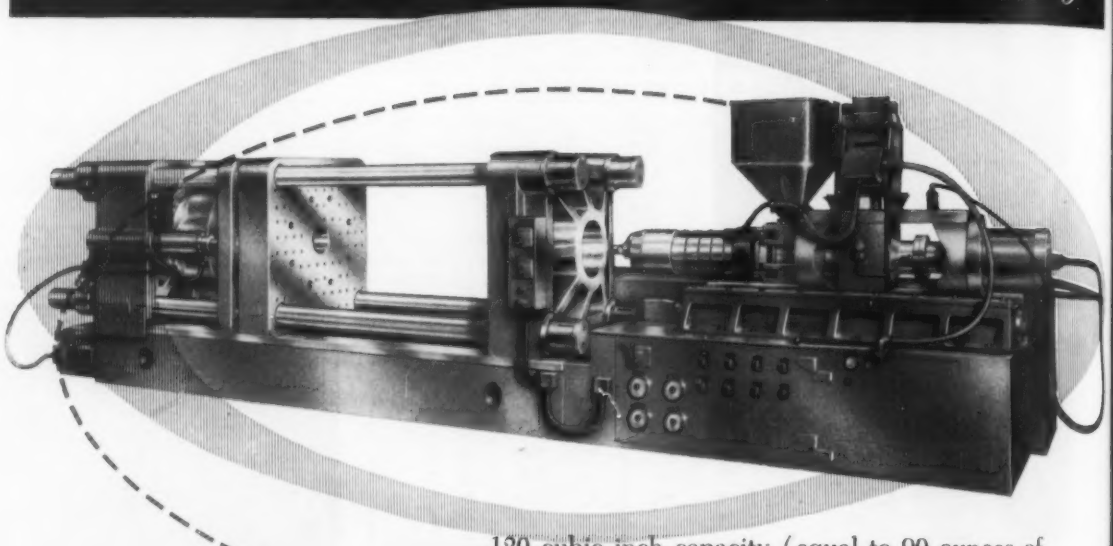
THE NEW!

A.P.120

INJECTION MOULDING MACHINE

WITH THE BUILT-IN REPUTATION

A 1957 addition to the world famous Windsor range



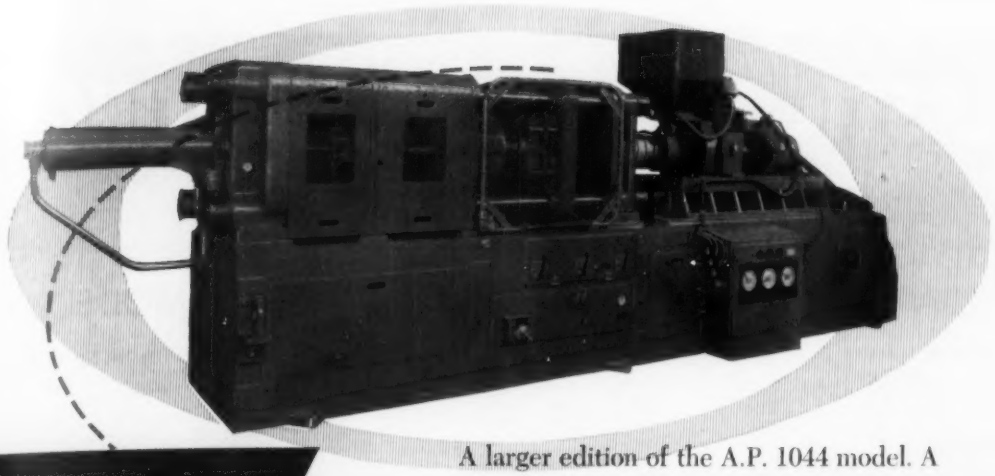
all these outstanding features are in the latest Windsor model

120 cubic inch capacity (equal to 90 ounces of Cellulose Acetate). "Autoplas" multi-screw pre-plasticising and injection unit, hydraulically retractable. Vickers-Detroit type control gear with Vickers Armstrongs' delivery pumps. Power unit incorporates 50 h.p. motor and pumps. Mould locking force of 750 tons. Main locking ram, cylinder and the moving platen move easily as a unit to take moulds of varying thicknesses. Separate heating control cabinet.

Fully illustrated literature of the complete range of Windsor machines is available on request.

SERVING THE WORLD'S PLASTICS INDUSTRY
Windsor
PLASTICS MACHINERY
TRADE MARK

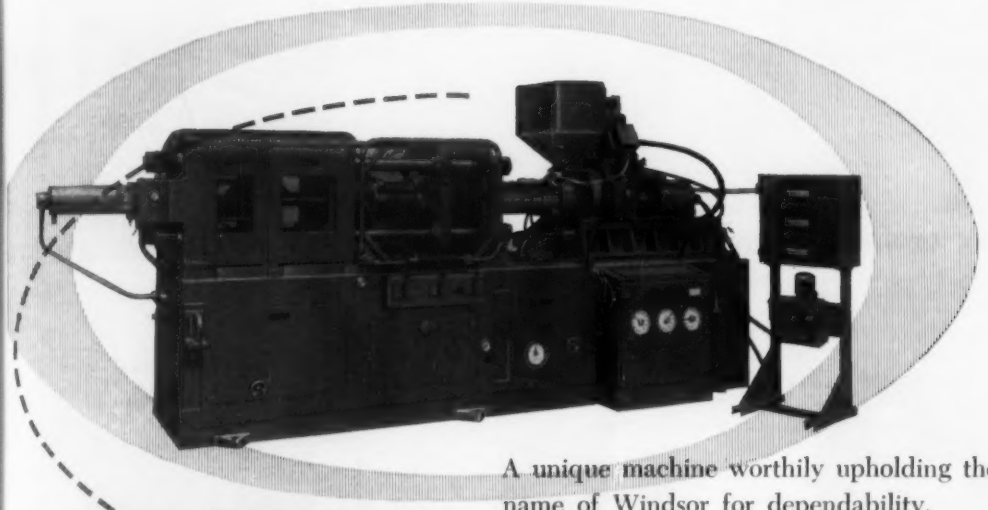
R.H. Windsor LTD



which includes

... the A.P. 2088

A larger edition of the A.P. 1044 model. A machine inspiring confidence by its very appearance and proves itself by its exceptional performance. Fitted with the "Autoplas" twin-screw type pre-plasticiser, will mould products up to 88 cubic inches equivalent to 64 ounces of Cellulose Acetate. Projected moulded area of 300 square inches.



... and A.P. 1044

A unique machine worthily upholding the name of Windsor for dependability. Incorporates the twin-screw pre-plasticiser and is completely self-contained. Produces mouldings up to 44 cubic inches per shot, equal to 32 ounces of Cellulose Acetate and offers a projected area of 160 square inches.

Office and Works:
THERHEAD ROAD · CHESSINGTON · SURREY · ENGLAND
Office: **49 UPPER BROOK STREET, LONDON, W.1. ENGLAND**
Representatives: **WILMOD CO., Plastic Division, 2488 Dufferin Street, Toronto**

For FASTER, BETTER RESULTS in

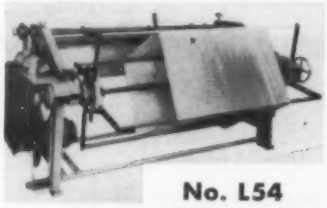
PLASTIC SLITTING & SHEETING

DO IT with DOVEN

MODERN PLASTICS PROCESSING EQUIPMENT

25 STANDARD MODELS *plus* CUSTOM-BUILT MODELS

FOR CONVERTING PLASTICS (2 to 40 gauge) CELLOPHANE, POLYETHYLENE PLIOFILM, ACETATES, RUBBER, TEFLON, LEATHERETTE, PAPER, CLOTH, . . . any old or brand new material. PROMPT DELIVERY!



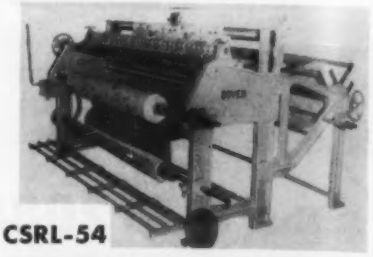
No. L54

DRUM-TYPE SHEETER

For all Plastics, Cellophane, Saran, Acetate, Polyethylene, Paper, Cloth

YOU'LL DO BETTER WITH DOVEN

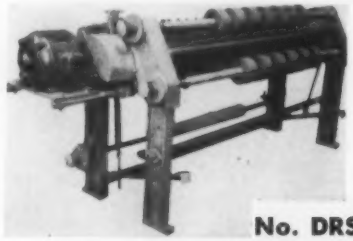
scientifically engineered for every slitting, rewinding, converting need.



No. CSRL-54

COMBINATION SLITTER-SHEETER

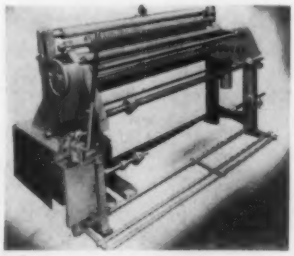
For Plastics, Cellophane, Polyethylene, Cloth, Leatherette



No. DRS-54-72

DUPLEX REWIND SLITTER

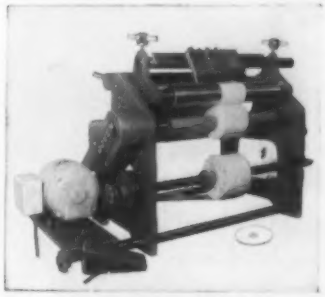
For Plastics, Cellophane, Acetate, Polyethylene, Saran, Paper, Cloths



No. SR-54

SINGLE REWIND SLITTER

For Plastics, Polyethylene, Cellophane, Leatherette, Coated Fabrics, Cloth



No. BRS-12-18

TEFLON BENCH SLITTER

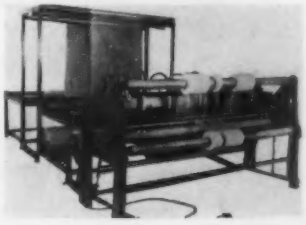
For Teflon, Plastics, Polyethylene, Cellophane, Saran, Aluminum Foil, Condenser Tissue as thin as .00025



No. RD1700-24

DUPLEX BENCH SLITTER

For Plastics, Polyethylene, Cellophane, Saran, Paper, Foil, Cloth



No. FG-90

FIBREGLASS SLITTER

For fibreglass, woven or matted with pneumatic score cutters

WRITE, PHONE FOR PHOTOS,

FULL DETAILS ON DOVEN Precision Plastic EQUIPMENT TODAY

DOVEN MACHINE & ENGINEERING CO.

2706 W. Van Buren St. • CHICAGO 12, ILL. • PHONE SAcramento 2-3355

A NEW
COST REDUCING FEATURE

"AUTOMATION in PLASTICS"

NOW POSSIBLE WITH THE *Logan*

HYDRAULIC PREFORMER



FOR HIGH BULK MATERIALS

Rag or flock filled, melamine "Fines" or general purpose materials can be preformed automatically. Large die area permits production of maximum size preforms. Multiple cavities can be used for smaller preforms. Processing with high bulk materials in your plant becomes automatic if you own a Logan Preformer.



If You Need a Hydraulic Press,

Check LOGAN Before You Buy

Automatic molding with Logan horizontal transfer machines and using preforms of high-bulk-factor type materials is the new way to reduce costs. Logan also has a complete line of semi-automatic molding custom engineered presses for compression and transfer use. Their exclusive features will appeal to you.

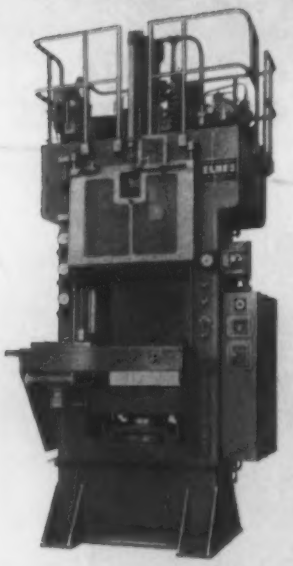
You will find it profitable to discuss your production problem with a Logan Engineer.

LOGAN HYDRAULICS, INC.

A SUBSIDIARY OF LOGAN ENGINEERING CO.

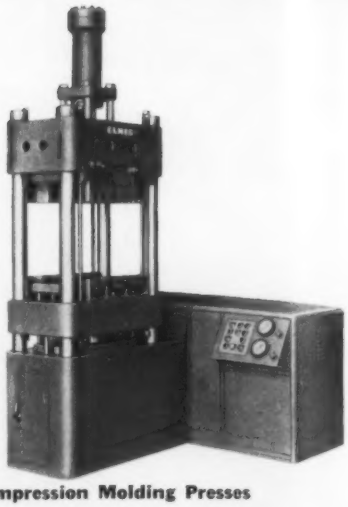
4901 WEST LAWRENCE AVENUE • CHICAGO 30, ILLINOIS

For press performance at TOP PROFITS...



Are Your Requirements Special?

There are times when a standard press won't do. An example is the Elmes custom-built 200-ton Transfer Molding Press shown at left. If your requirements are special, and whether they call for a press newly designed throughout or just modification of an existing design, Elmes background, facilities, and foresight can save you many dollars—assure you press performance at its best.



Transfer and Compression Molding Presses

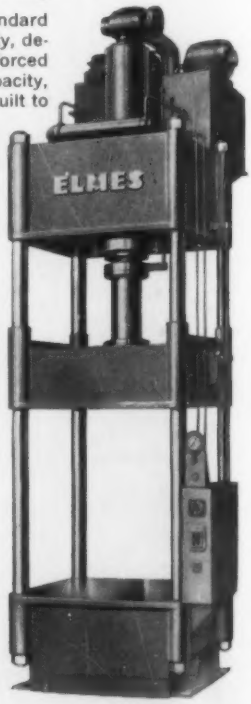
The standard design molding press illustrated above is typical of the Elmes full range of sizes for fast, accurate, economical production. Convenient pushbutton panel; pushbutton pneumatic reset of lower knockout; automatic position slow-down; extra large die space; many other features. Compression presses from 50 to 1000 tons. These presses are adaptable to practically any kind of molding problem with no changes other than dies and control settings.

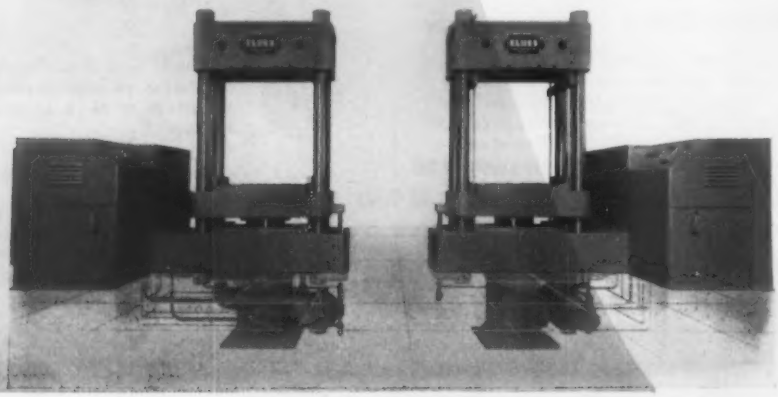
Installation of "Twin" Compression Molding Presses

The twin molding presses illustrated below make a compact installation, enabling one man to operate both presses. The presses are identical except that one is equipped with left-hand and one with right-hand controls and top knockouts. In addition to greatly improved ease of operation, time-saving convenience in servicing also has been achieved in the installation. Both presses are four-column moving-up type. Each press has a capacity of 300 tons. Here is an example of a typical adaptation of a standard Elmes Press design to provide equipment exactly suited to the job.

Presses for Reinforced Plastics Molding

Elmes offers a complete line of standard presses from 50 to 600-tons capacity, designed specifically for molding reinforced plastics. Standard models of larger capacity, or custom-designed models, can be built to suit special requirements. Fully pushbutton controlled. Rapid advance, automatic slow-down, pressing speed adjustable to practically 0" per minute. Stripping speed can be controlled by the operator from maximum to approximately 0" per minute. Timer can be pre-set for cure cycle desired. Return stroke is adjustable to any determined length.



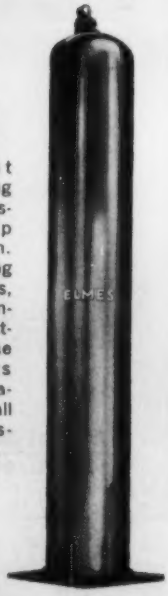


ELMES *"Job-Fitted"* HYDRAULIC PRESSES

Elmes® plastics molding equipment, backed by over a solid century of engineering experience, is convenient and simple to use . . . fast, flexible, and economical to operate. And most important—whether it is a standard Elmes design or a unit custom-built to meet special needs, an Elmes Press is always "job-fitted" to the customer's production requirements. For all kinds of pressure applications in the plastics field you can count on Elmes for performance that turns cost figures into profit figures.

Elmes offers a complete line of *standard* equipment, including compression and transfer presses; Hydrolairs®—power presses requiring neither pumps nor motors; small-production, laminating, and laboratory presses; and Elmes pump-accumulator systems for group press operations. Or if your requirements call for *special* designs, Elmes engineers can develop equipment to suit your particular needs.

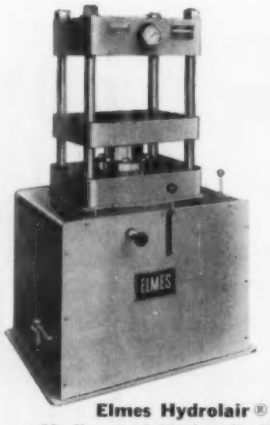
For detailed information on Elmes plastics molding equipment, contact your Elmes Distributor, or write to us direct.



Air-Ballasted Accumulators

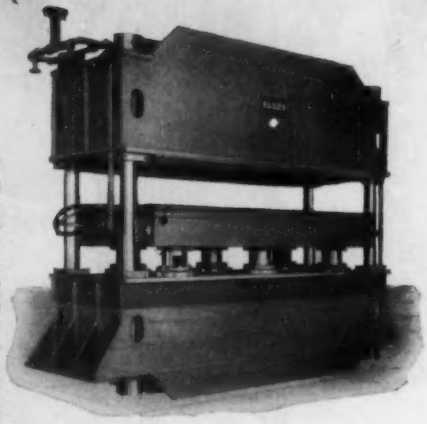
Today's best means for storing liquid under pressure for group press operation. No internal moving parts, no packings, no leakage. Compressed air ballasting eliminates line shocks, permits pressure regulation. Made for all industrial pressures, capacities.

IT DOESN'T COST TO OWN AN ELMES PRESS . . . it pays!



Elmes Hydrolair® Air-Powered Hydraulic Presses

Hydrolairs are the most economical of all power presses to buy and use. No pumps or motors. Powered by shop compressed-air line. Hydrolairs deliver selected pressure and maintain that pressure, even on compressible materials. Available in 30, 50, 75 and 100-ton models, with or without hot plates, and with either hand lever (illustrated) or electric control. Furnished as complete "package" units with nothing else to buy.



Hot Plate Molding Presses

Illustrated is a 450-ton Elmes Hot Plate Press equipped with six single-acting cylinders set into the press bed unrestrained. Rams bear against finished pads beneath the moving platen. Pushbutton control. Press system is arranged so that only two center cylinders may be actuated if desired. Dual-pressure pump provides a high closing speed and moderate pressing speed.

AMERICAN STEEL FOUNDRIES

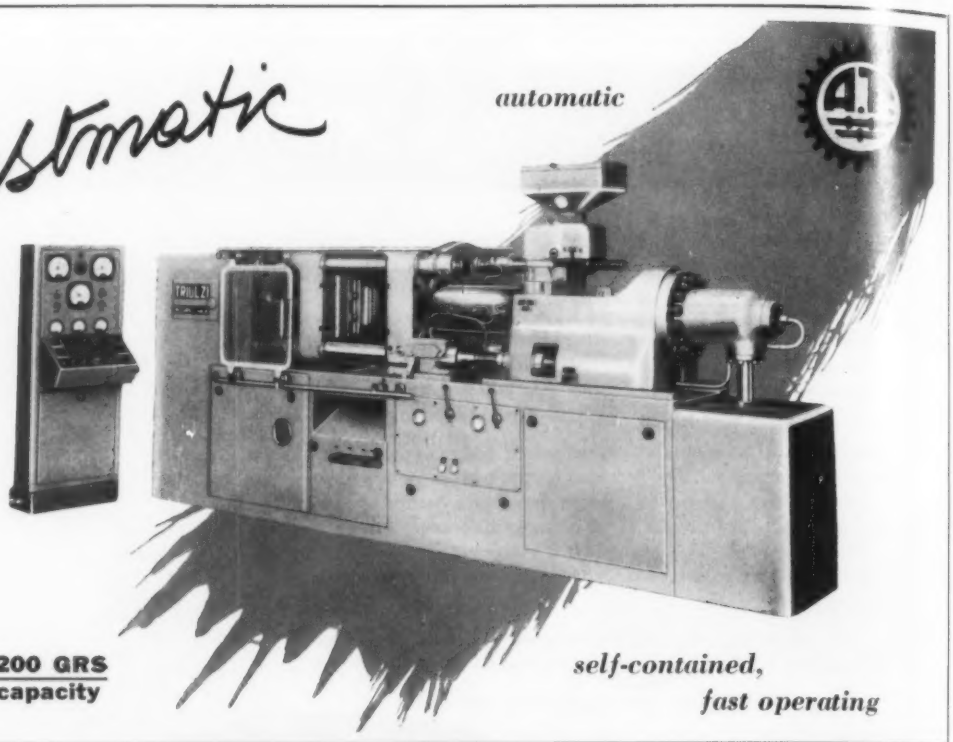
Elmes ENGINEERING DIVISION

1153 Tennessee Avenue, Cincinnati 29, Ohio

METAL-WORKING PRESSES • PLASTICS MOLDING PRESSES • PUMPS • ACCUMULATORS

Plastmatic

automatic



Model 200 GRS
7 oz. capacity

self-contained,
fast operating



2 oz. vertical injection molding machine

60 ton automatic self-contained compression molding press

Multiple platen press for rubber and plastics laminates

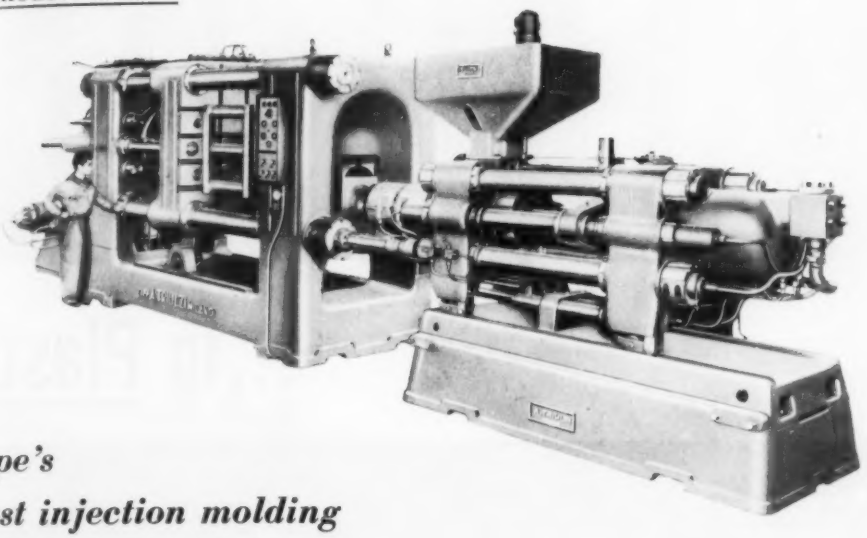
Special press for polyester resins

MILAN, ITALY (640)

VIA GIOVANNI DA PROCIDA, 8

Telegrams: TRIULZIPRES – MILAN

Model PL 6/10



Europe's biggest injection molding machine with an injection capacity up to 350 ozs.

TRIULZI'S production line for plastics:

- **INJECTION MOLDING MACHINES:** hydraulic, self-contained, automatic, horizontal and vertical.
- **COMPRESSION AND TRANSFER MOLDING PRESSES:** hydraulic, self-contained, with automatic dosing device.
- **PRESSES FOR REINFORCED PLASTICS**
- **PRESSES FOR RUBBER AND PLASTICS LAMINATES**
- **HOBBING PRESSES**

Don't forget that

TRIULZI

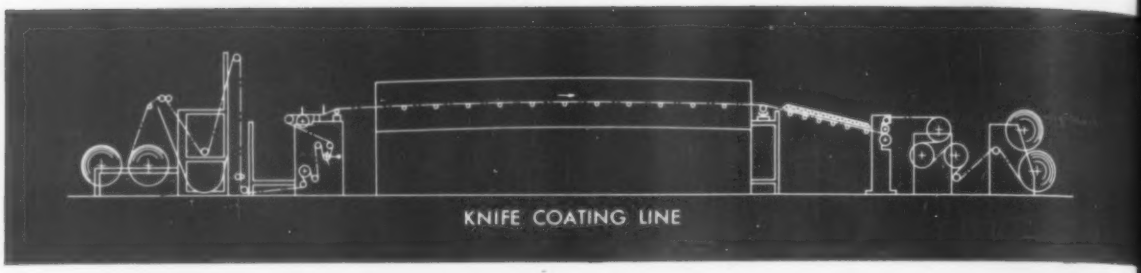
manufactures the very machine you need for your plastics job!

Write for free literature today!

TRIULZI S. A. S.

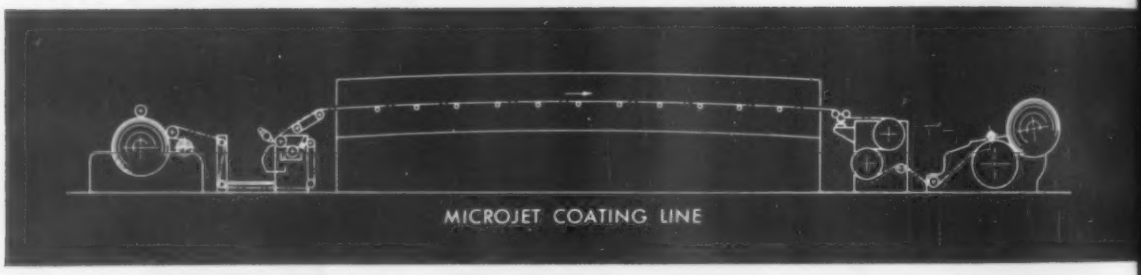
WALDRON

...in Plastics



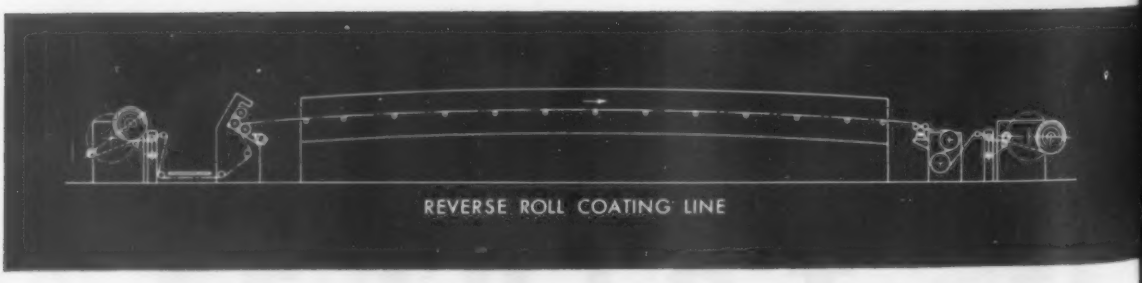
KNIFE COATING LINE

from the Industry's



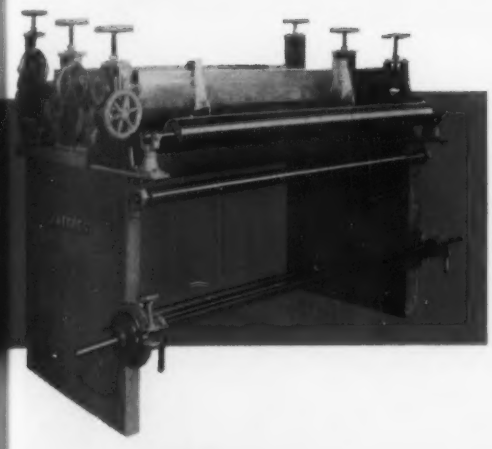
MICROJET COATING LINE

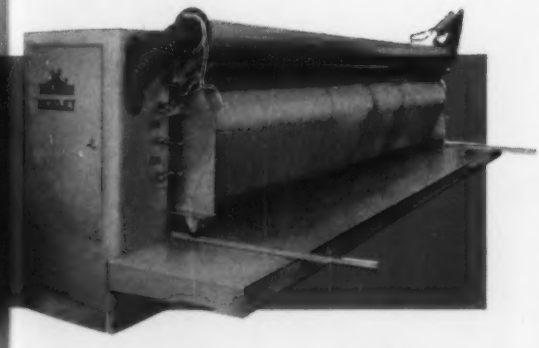
Pioneering Days..

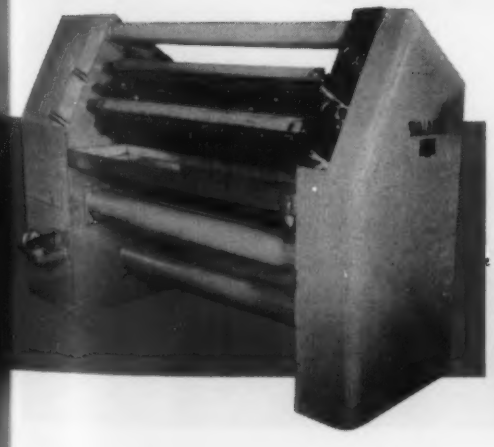


REVERSE ROLL COATING LINE

.130 Years in Web Processing Generally







★ Formations of Plastic Films
★ Decoration of Plastic Films
★ Slitting and Winding
★ Laminating

The John Waldron Corporation has been in continuous business now for 130 years. This in itself might be of only passing interest but for the fact that web processing has always been our business. Even in the earliest days, our business sign could have read . . . 'Designing and Manufacturing Machines for Processing Webs, Sheets or Ribbons'.

Paper came first, followed by rubber and when other plastics began to come into the market, Waldron design engineers were right in the center of things. As the plastics industry expanded—both in kind of plastics and in uses—it was generally a Waldron machine that took care of the web processing steps involved.

Today, the scope of Waldron design and manufacturing service in connection with the processing of plastic webs is as broad as the plastics industry itself. But it is significant that in our whole experience, we have seldom made two machines exactly alike, except for repeat orders. That's the peculiarity of web processing. Rarely are two problems alike, thus precluding the manufacture of so-called 'stock designs'.

Waldron Engineers are fully experienced in all web processing problems. If you have any machine requirement coming up in the near future, why not discuss your problem first with a Waldron engineer? He might be able to contribute something very helpful to your planning.



As a preliminary step to a discussion, send for our general catalog (No. 125) on WALDRON Plastic Processing Machinery.

THE ROSS GROUP
OF COMPLEMENTING SERVICES

With all the experience in Web Processing these 130 years in business imply

JOHN WALDRON CORPORATION

1827 1957

NEW BRUNSWICK, NEW JERSEY
CHICAGO LOS ANGELES

Member of Society of Plastics Industry



This DIAL Will Increase Production On Your Extruder

This dial, which controls the Reliance V•S Drive, accurately sets and maintains exact speed control to insure uniform product consistency.

With a Reliance V•S Drive, an extruder lends itself to production of a wide range of materials, regardless of speed requirements.

With the wide speed range of a Reliance V•S Drive you can operate at the highest possible production rates, regardless of material. This wide range of speeds permits the extruder to be coordinated with conveyors, laminators, or any other equipment.

Operating from your plant a-c power source, a Reliance V•S Drive is built to give years of trouble-free performance without costly maintenance.

Whether it's for the extrusion of acrylics, polyethylene, vinyl, or *any* thermoplastic or "cold-set" plastics, a Reliance V•S Drive will help you maintain a more efficient and profitable operation. D-1849

Write or call for further details.



RELIANCE ELECTRIC AND ENGINEERING CO.

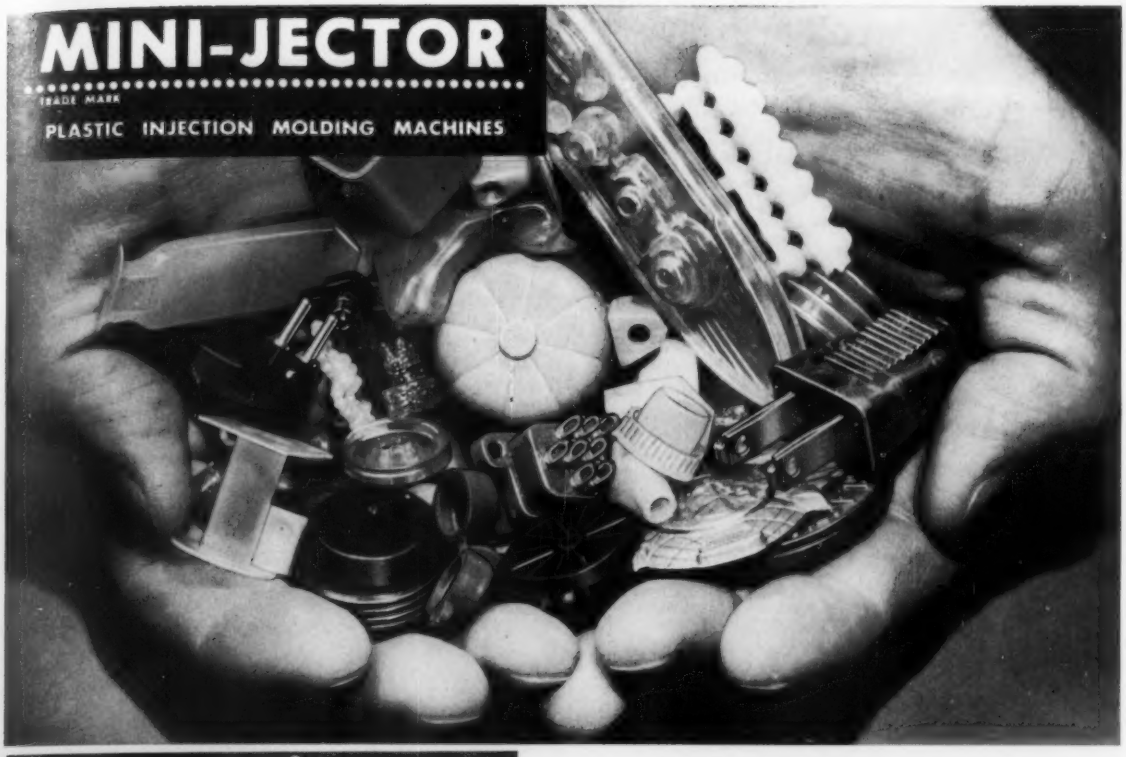
DEPT. 15A, CLEVELAND 17, OHIO • CANADIAN DIVISION: WELLAND, ONTARIO

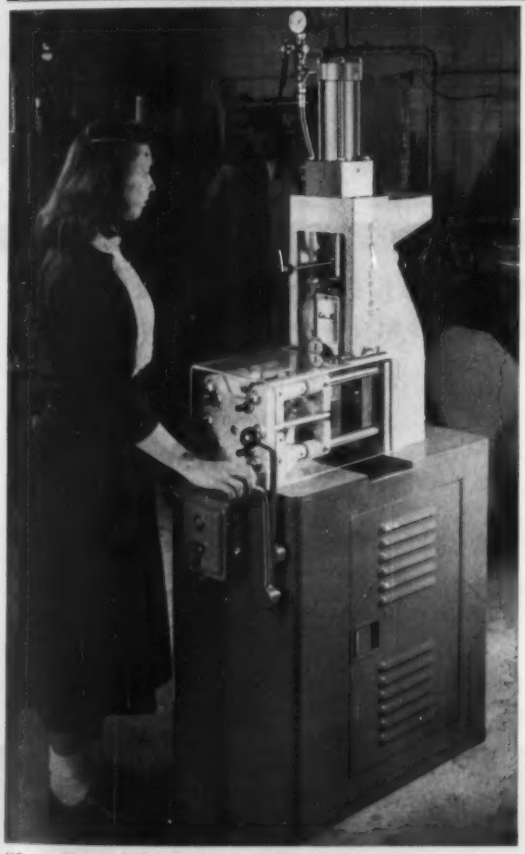
Sales Offices and Distributors in principal cities

MINI-JECTOR

TRADE MARK

PLASTIC INJECTION MOLDING MACHINES





"Super-Hornet" Power-Operated, Lever-Controlled
One of many models in "Hornet" and "Wasp" Series to suit your needs.

MORE VARIETY at LOWER COST!

Saved: Thousands of dollars in mold costs with versatile, economical MINI-JECTOR. Eliminate "big press" high-per-piece tooling charges!

The more variety, the bigger the savings! Flexible, efficient, MINI-JECTOR Plastic Injection Molding Machines fill your need for low-cost development and production of fast-changing varieties of small molded plastic items. Savings begin with low initial investment of machine (under $1,000) and molds (as low as $29.50). Even more important are the bigger savings in time, trouble and money developing and producing "varieties" of different items by eliminating complex, costly big-press tooling where not required. MINI-JECTOR solves your tricky "insert" molding, too. Compact, simple to operate. Mold cap. 1/3 oz. to 1 oz., all thermoplastics and Nylon. Lever and push-button control models, air or hydraulic power to fit your facilities. Users claim MINI-JECTORS pay for themselves many times over in *savings alone.*

Bring your requirements to Newbury! Our engineers can help you select the model MINI-JECTOR to develop and produce your small (up to 1 oz.) plastic items at lower cost than previous methods.



Write for Catalog today! "Tell-all" booklet, completely illustrated, shows entire line of MINI-JECTOR Plastic Injection Molding Machines and accessories. Learn how MINI-JECTOR adds new flexibility and economy to your plant operations.

NEWBURY INDUSTRIES Inc.

Box 3800, Newbury, Ohio

"Plastic Injection Molding Machines up to One Ounce Capacity"

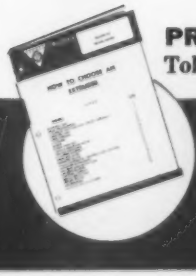


PRODEX EXTRUDERS

PRODEX P.V.P. VENTED EXTRUDERS • L/D 24:1 and 30:1 • are outperforming other machines in leading plants throughout the World.

- ✓ **POLYSTYRENE SHEET** ..... without Predrying
- ✓ **HIGH DENSITY POLYETHYLENES** ..... from Powder Feed
- ✓ **CABLE JACKETING** ..... without Porosity
- ✓ **CALENDER FEEDING** ..... without Banbury or Mills
- ✓ **CONTINUOUS COMPOUNDING** ..... for Wire, Cable, Records and Reclaiming with Excellent Dispersion
- ✓ **DEVOLATILIZING** ..... Continuous Removal of Monomers, Moisture, etc.

PRODEX P.V.P. EXTRUDERS perform these operations within Close Tolerances and at Higher Output Rates

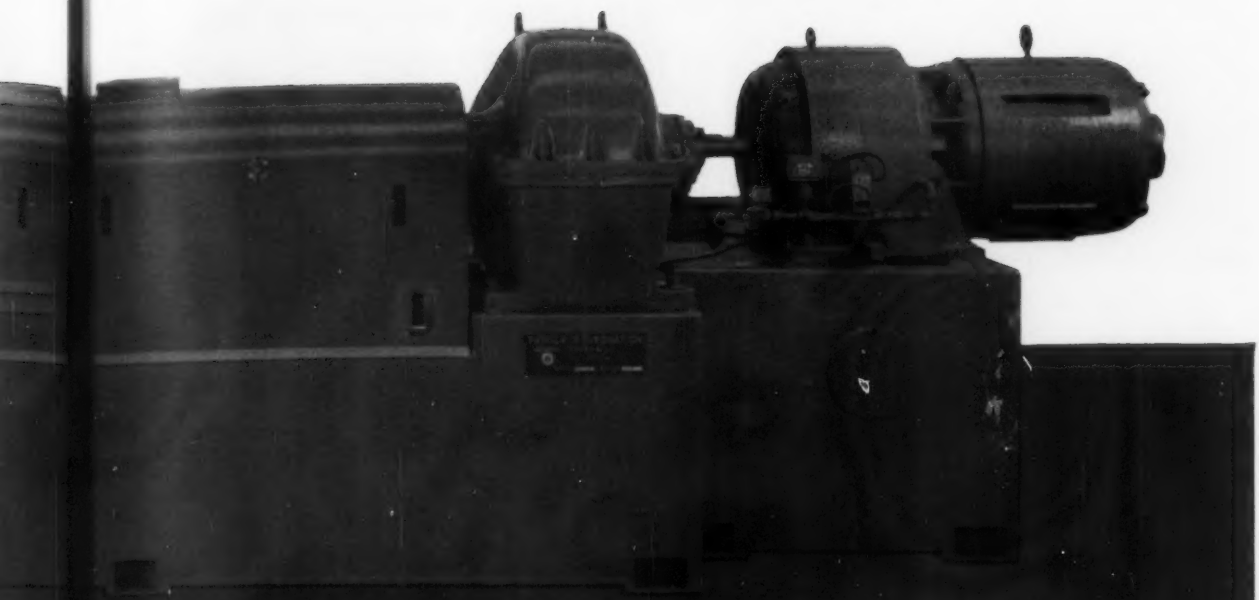


Send for Bulletin E-3, Second Edition, for complete details.

Arrange for a Demonstration today on your Material.

Package Installations for Sheet, Film, Pipe, Wire and Cable, Continuous Compounding and Laminating.

PRODEX EXTRUDERS are available in 1¾", 2½", 3½", 4½", 6" and 8" Sizes.



RS DO IT BETTER . . .

PRODEX NON-VENTED EXTRUDERS • L/D 20:1 and 24:1 • have set New Standards of Performance in Precision and Output Rate when Venting is not required. Sound Engineering and Advanced Instrumentation guarantee Easy and Trouble-free Operation.

- ✓ **GENERAL CUSTOM EXTRUSION** . . . . . for Wide Variety of Compounds and Cross-sections
- ✓ **FILM EXTRUSION** . . . . . Polyethylene and Vinyl
- ✓ **LAMINATING** . . . . . Paper Coating, Plastic to Plastic
- ✓ **VALVED EXTRUSION** . . . . . Interrupted for Molding, Continuous for Dispersions

PRODEX CORPORATION • FORDS, NEW JERSEY

HILLCREST 2-2800 • Manufacturers of Process and Extrusion Machinery

Using Epoxy?



use Hardman TRIPLEMATIC* pumps

DESIGNED by experienced custom compounders

PROVEN in over 2 years of production service. It meters - mixes - pumps 2-part pourable resins.

* Trade Mark $2,000

H. V. HARDMAN CO., INC. 571 CORTLANDT ST.
BELLEVILLE 9, N.J. PLYMOUTH 9-1242

- **Trimming Dies**
  for vacuum formed plastics
- **Steel Cutting Dies**
  from ¾" high to 12" high
- **Electronic Heat Sealing Dies**
  for flexible and rigid vinyl
- **Mallet Handle and Steel Rule Dies**

LIBERTY designs and manufactures efficient dies for every plastics cutting, trimming and sealing requirement.

fast service

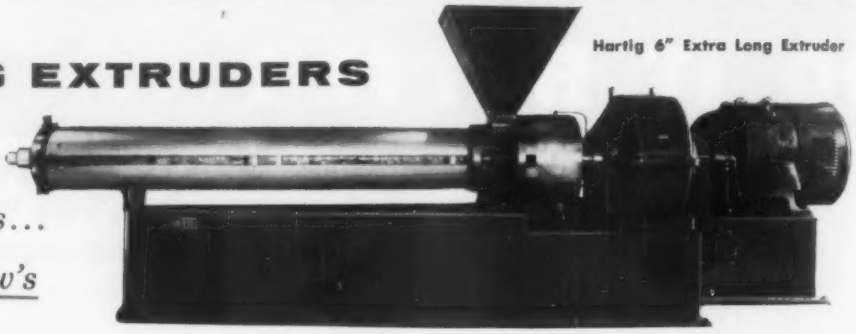
Send prints, sketches, or sample parts for a prompt estimate.

LIBERTY CUTTING DIE COMPANY
65 Bleeker St. New York 12, N. Y. Phone: SP 7-5005

HARTIG EXTRUDERS

Designed for Today's Needs... and Tomorrow's

Hartig 6" Extra Long Extruder

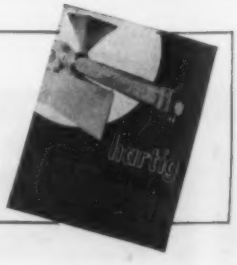


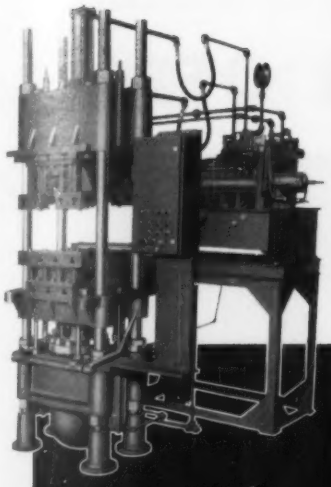
Extruders from 1¼" through 12" bore | Standard 15:1 L/D | Extra Long 21:1, 24:1 & 30:1 L/D

Auxiliary equipment includes film and blown tubing dies, take-up units, pelletizers, polishing assemblies.

HARTIG EXTRUDERS
ESTABLISHED 1890
1137 GLOBE AVENUE, MOUNTAINSIDE, N. J.
Mailing Address: P. O. BOX 531, WESTFIELD, N. J.
Chicago Representative:
C. J. BERINGER, 727 ECHO LANE, GLENVIEW, ILLINOIS

Send for your copy of the new booklet describing the complete line of Hartig Extruders and auxiliary equipment.





Plastic - Molding Equipment

Specially Designed for

LOW-COST PRODUCTION

•

LOW-COST MAINTENANCE

Semi-Automatic **PRESSES**

Self-contained or Central System

Single or Double Ram for High Speed Transfer Molding

Heating Presses

Cooling Presses

Hand Presses

Pressure PUMPS

Power Pumps

ACCUMULATORS

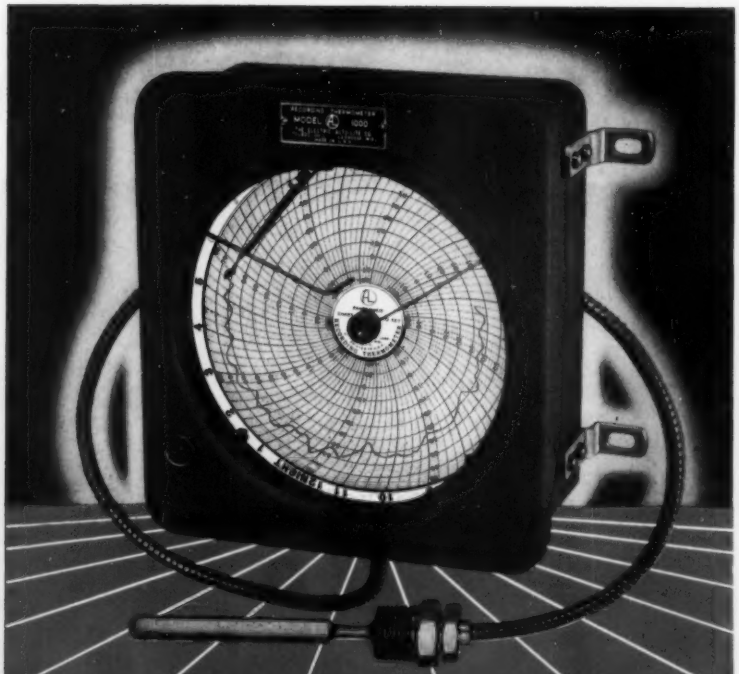
Hydraulic VALVES

Shock Alleviators

•

Write for Catalogs

Dunning & Boschert
PRESS CO., INC.
330 W. Water St., Syracuse 4, N. Y.



KEEP TEMPERATURE IN SIGHT WITH AUTO-LITE

Here's your most trustworthy watchman—made by Auto-Lite to chart every change of temperature during operating cycles. Put this recorder to work wherever temperature behavior can affect operating efficiency or product quality.

Newly designed, Model "1000" Recorders with 6" clear reading charts are uniformly responsive throughout their entire temperature range. Various standard ranges from minus 40°F to plus 550°F. Available for wall mounting or portable use. Electric or mechanical chart drive. With capillary tubing for remote reading. Priced from $49.50. Send for new catalog describing Auto-Lite Temperature Recorders and Indicators.

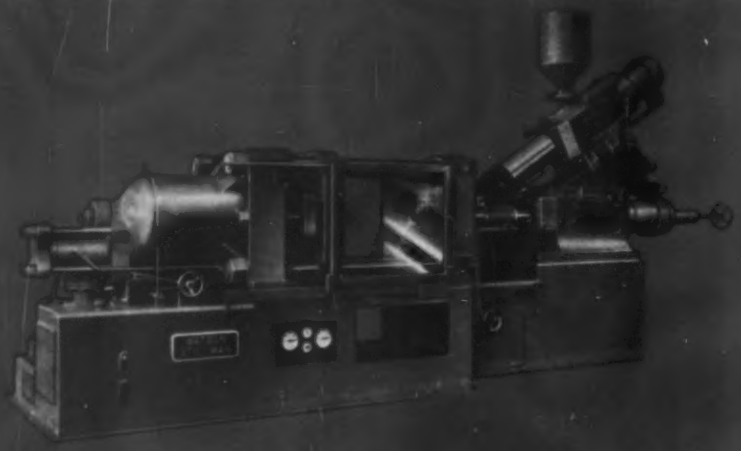
CHOICE OF 24-HR. OR 7-DAY CYCLE

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS AND INDICATORS

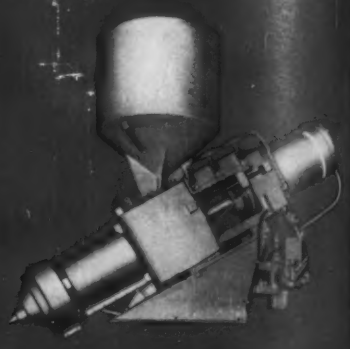
When you're in the market for molding machinery...

WATSON-STILLMAN OFFERS



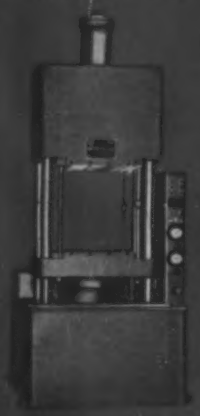
HORIZONTAL INJECTION MOLDING MACHINES

Automatic and semi-automatic, high-speed machines for molding all types of thermoplastics. Latest features assure flexibility required to mold a wide variety of compounds and intricate parts. Capacities: 5 to 500 ounces.



PREPLASTICIZING UNITS

Watson-Stillman preplasticizers give higher capacities, shorter molding cycles, lower injection pressures, material savings and improved product quality. Units can be installed on all standard horizontal molding machines from 16 to 85 ounces.



TRANSFER MOLDING MACHINES

Standard four-column designs incorporating the latest features for molding thermosetting compounds. Ideal for small insert parts and cores. Feature adjustable opening to accommodate a variety of mold sizes. Capacities: 30 to 2000 tons.



COMPRESSION MOLDING PRESSES

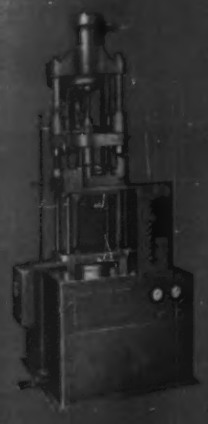
Of the same basic design as transfer presses, they can be converted with transfer cylinder. Standard equipment includes bolsters, parallels, degassing, adjustable openings, top and bottom strippers and push-button control. Capacities: 50 to 2000 tons.



GENERAL PURPOSE PRESSES

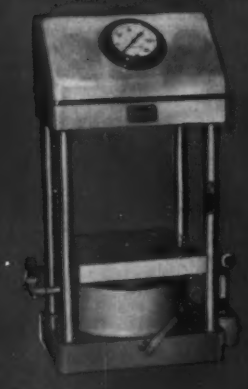
For molding, laboratory and experimental work or for use as a laminating press. Micro pressure adjustment makes these presses ideal for testing purposes. Electrically operated automatic single-cycle control governs press dwell under pressure. Capacities: 30, 50, 100, 200 tons.

ALL THESE ADVANTAGES:



VERTICAL INJECTION MOLDING MACHINES

Designed to meet the need for low-cost high-speed production of small intricate moldings. In addition, these units are well adapted to molding parts requiring inserts. Capacities: 1, 2, 6, 16, 20 and 24 ounces.



LABORATORY PRESSES

Designed for experimental work and wherever pressures of 30 to 100 tons are required on comparatively small areas. Ideal for die work, laminating and hot or cold molding. Optional electric or steam heating plates. Capacities: 30, 50, 100 tons.

EXTENSIVE LINE

Whatever your production objectives . . . you can meet them from the Watson-Stillman "Completeline" of plastics molding equipment. The line features both standard and special machinery for all applications—in a broad range of sizes and capacities.

ADVANCED DESIGN

Pioneer experience, plus a continuous research and development program, combine to offer machines of consistently high quality and "years-ahead" design. That's why modern efficiency is yours when you specify Watson-Stillman.

ENGINEERING SERVICE

Watson-Stillman engineers have helped thousands of manufacturers to select the right equipment for a specific job – in boosting production speed and efficiency. These men are ready to go to work on your problem, too, with a complete service from press design to final installation.

BROAD BACKGROUND

Established in 1848, Watson-Stillman is one of the oldest manufacturers of hydraulic equipment in the United States and a pioneer in the development of plastics molding machinery.

Next time you're in the market for molding machinery, remember the many advantages offered by Watson-Stillman. In the meantime, send for details of any of the equipment described.

WATSON-STILLMAN PRESS DIVISION

FARREL-BIRMINGHAM COMPANY, INC.

150 Aldene Road, Roselle, New Jersey

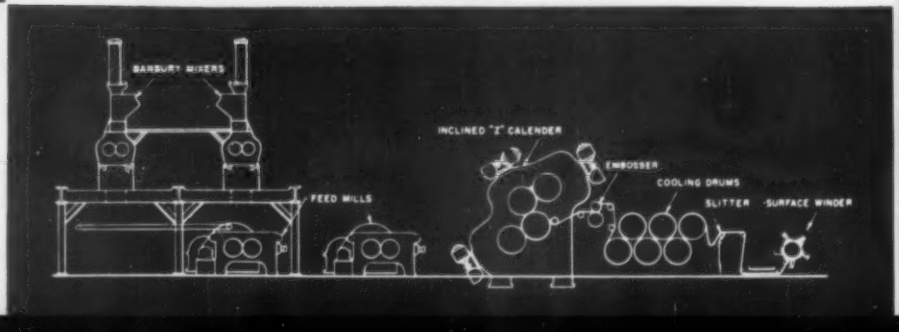
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
European Office: Piazza della Republica 32, Milano, Italy
Represented in Canada by Barnett J. Danson, 1912 Avenue Road, Toronto, Ontario
Represented in Japan by The Gosho Company, Ltd., Machinery Department, Tokyo, Osaka and Nagoya

W-S HYDRAULIC

F/B

Farrel-Birmingham also designs and manufactures equipment for processing plastic film and coating. Production units are matched in capacity for planned processing flow. Illustration: Matched production unit consisting of two 3A Banbury mixers two 22" x 60" mills and a 28" x 66" four-roll "Z" Calender. The size and design of the Banburys and mills assure an even flow of properly conditioned material to the calender. Calender is driven by an adjustable-speed motor so that output speed may be regulated according to the gauge of stock being run. Please address inquiries on plastic film processing and coating equipment to Farrel-Birmingham Company, Inc., Ansonia, Conn.

WS-34

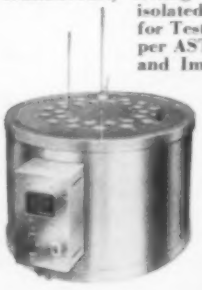


TO TEST PLASTICS AT EXTREME TEMPERATURES
in accordance with ASTM specifications

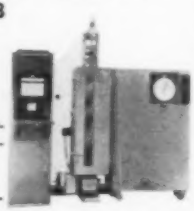
Scott provides world-standard equipment to determine the usefulness and endurance of synthetic elastomeric materials in modern applications such as jet propulsion, gas turbines, atomic energy plants, etc.

MODEL LG
TEST TUBE AGEING

Tests rubber samples at controlled elevated temperatures up to 550°F. Provides 28 compartments for simultaneously testing a number of isolated specimens for Test Tube Ageing per ASTM D865-54T and Immersion Test per ASTM D471-55T. Supplied COMPLETE with test tubes, closures and vent tubes for 28 chambers. (Also available: Model LGH, to 1000°F).



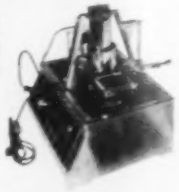
MODEL L-8
TENSILE



Model L-8 determines stress, strength, percent elongation and resistance to tear of elastomeric materials at temperatures from −70° to 500° F. It incorporates a self-contained conditioning unit with all controls to automatically maintain desired temperature. An illuminated chamber and fully insulated glass door afford full length visibility of the test chamber. For operation at room temperature, door is left open.

MODEL E — BRITTLENESS

Model E Brittle Point Tester with a range of +50° to −120°C is the accepted Industry standard for brittleness determination in accordance with ASTM Designation D746-52T. Portable and self-contained, with all controls to automatically maintain desired temperature. Operates by plugging into standard lighting circuit.



SCOTT TESTERS INC. 103 Blackstone St. Providence, R. I.

STATE YOUR PROBLEM — SOLVING YOUR TESTING PROBLEM IS OUR BUSINESS

Scott Testers — Standard of the World

Plastics Processing Equipment



Pull-Off Unit (Model PO 200) for pulling extruded belting, hose and similar shapes. Can be adapted for rigid pipe, embossing, and slitting. sizes: 4", 8", and 12".

Standard U.S. Vari drive, can be equipped with electronic drive.



Layflat tubing haul-off and surface winder (Model TU 300) has adjustable angle "Vee" assembly and gusseting attachment. Standard sizes from 20" to 96", other sizes on request. Speeds: up to 250 fpm.

Standard electronic drive.

You'll get superior results with the Faeco Constant Tension Turret Winder (Model TW 250), too.
This unit operates on its own electronic circuit, independent of the machine it is linked up with. Result: uniform tension throughout roll build up to finished roll. Winds variety of materials on cardboard tube. Sizes: 26" to 96". Speeds up to 300 fpm. Roll build up: 18" diameter, and larger on request.

Other Faeco plastics processing equipment includes:

- Blown Film Extrusion Dies
- Unwinders
- Laminators
- Casting Roll Units
- Sheet Take Up
- Printing Machinery (Rotogravure and Flexographic)
- Printing Cylinders
- Dry Blenders
- Water Bath Units
- Cooling Trough

Write for detailed information on these high production units.

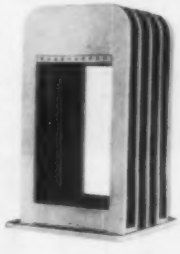
FAECO MACHINE CO., INC.
229 Preakness Ave., Paterson, New Jersey
Armory 4-8566

The new CUSTOM MULTIFRAME TRANSFER
compression molding and laminating press



A modern up-to-date patented hydraulic press designed for the increasingly rugged, severe duty demanded in the plastic molding industry today. Not a redesign of a press made 30 years ago but a completely new, all steel, streamlined, heavy duty press requiring a minimum of maintenance. We can furnish any tonnage, any diameter ram, any platen size, any stroke, any opening—to your exact specifications. Truly a "CUSTOM" press. No questionable castings used. All heavy rolled steel components.

▲ Custom Multiframe Transfer Press with transfer cylinder within main ram. Very popular design due to low overall height and ease of loading mold.



Custom MultiFrame ▶ Compression or Laminating Press



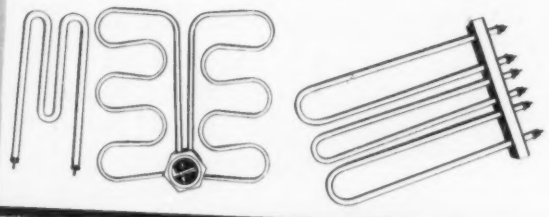
CUSTOM MACHINE & DESIGN, INC.
200 SOUTH FORGE ST. Tel. HEmlock 4-3915 AKRON 9, OHIO

GLENN ELECTRIC HEATER CORPORATION

Designers and manufacturers of industrial heaters

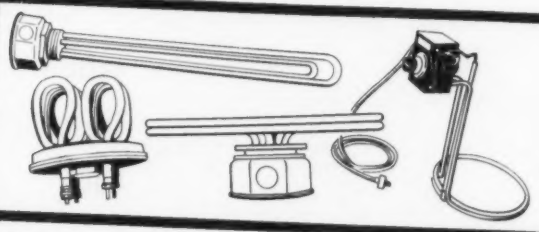
tubular heaters

Most heating applications require tubular heaters to be bent



immersion heaters

provide maximum heat transfer at minimum expense.



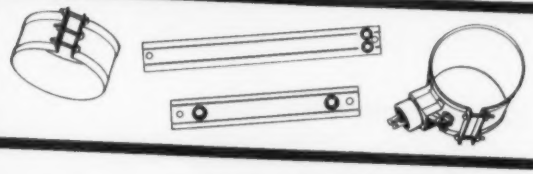
cartridge heaters

for insertion in small areas requiring concentrated heat.



space heaters

Glenn strip and band heaters are built to meet the most exacting requirements.



hot plates custom-built units

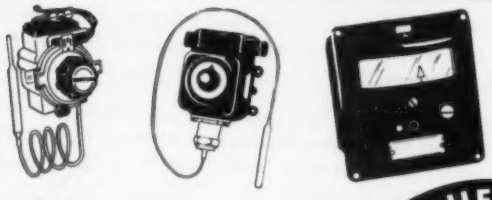
infrared panels at prices

ovens competitive with 'standard' units.



thermostats

robertshaw
wheelco
partlow



FOR INFORMATION • TECHNICAL ADVICE • ENGINEERING

write or phone

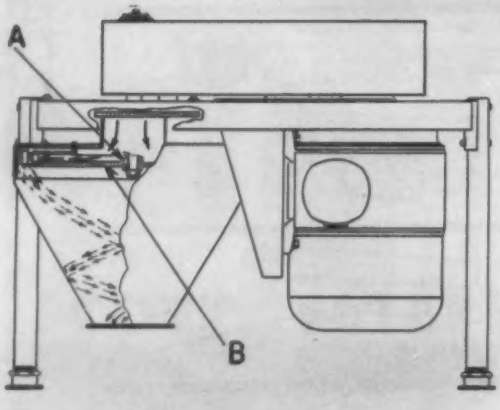
GLENN ELECTRIC HEATER CORPORATION

372-376 JELLIFF AVENUE • NEWARK • NEW JERSEY

TELEPHONES • N. J. TALBOT 4-2171 • N. Y. CANAL 6-7300

GLENN ELECTRIC HEATER CORPORATION

for DISPERSION...
for PARTICLE SIZE REDUCTION...
"ENTOLETER" CENTRIFUGAL MACHINES...



assure these Cost Saving Advantages...

- LOW HORSEPOWER REQUIREMENTS
- DIVERSITY OF PRODUCT APPLICATION
- LARGE OR SMALL CAPACITIES
- ADAPTED TO BATCH OR CONTINUOUS SYSTEMS
- DEPENDABLE OPERATION

Operation of the "Entoleter" Centrifugal Machine:

The product is fed by the inlets and distributor to the center of the rotor (A) consisting of two steel discs (B) spaced approximately one inch apart by specially designed impactors.

The material is spun out, by centrifugal force, into a thinning film as it approaches the periphery of the rotor. Powerful uncushioned impact action causes every particle of the material to be thoroughly processed by the "ENTOLETER" CENTRIFUGAL MACHINE.

For descriptive bulletins or information on free application tests in our Development Laboratory . . . contact the ENTOLETER DIVISION, P.O. Box 904, New Haven, Connecticut.

ENTOLETER DIVISION
SAFETY INDUSTRIES, INC.
P O Box 904 New Haven 4, Conn.

New Used Rebuilt

MACHINERY

for the
Rubber and Plastics
Industries

MILLS • CALENDERS
MIXERS • GRINDERS
EXTRUDERS • CUTTERS
TABLET PRESSES • PELLETIZERS
INJECTION MOLDING MACHINES
HYDRAULIC PRESSES
PUMPS • ACCUMULATORS
TOOL ROOM EQUIPMENT
All Types and Sizes
MACHINE TOOLS
BOILERS • MOTORS
COMPRESSORS, etc.

What do you need?
What have you to sell?

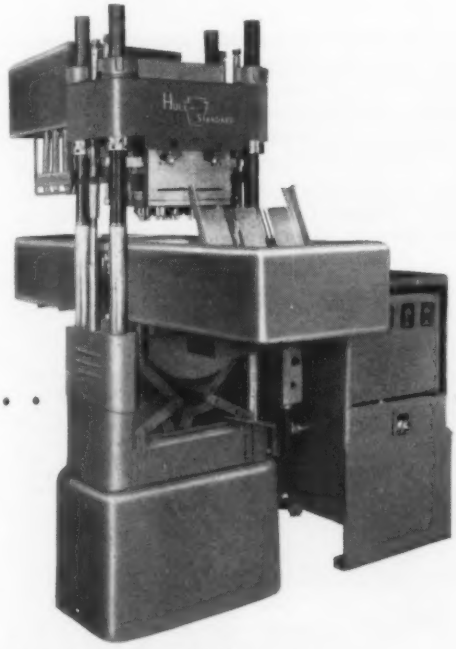
JOHNSON
Dept. PE
MACHINERY CO.
683 Frelinghuysen Ave.
Newark 5, N. J.
BIgelow 8-2500

Please place us on your mailing list.

HULL-STANDARD OFFERS

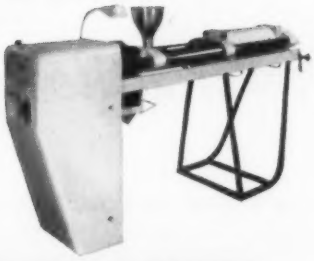
Thermosetting Plastics Molding Presses for Every Purpose!

Hull-Standard Presses—backed by over 20 years of experience in the plastics molding industry and nearly 2000 Standard Presses—now offers you a choice of Standard Presses to exactly meet your molding needs.



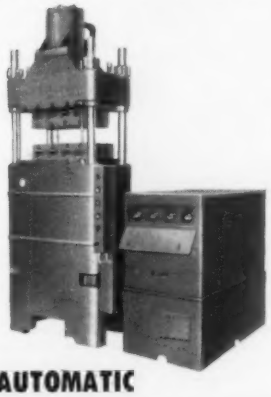
COMPLETELY AUTOMATIC COMPRESSION MODELS

New, high speed, cost-cutting press offers you: HIGH PRODUCTION (Cycle less than 12 sec. dry cycle, *plus* large die area, 18" x 18¾"). ECONOMY (Only one operator for up to 10 presses. Low power requirement 3 hp. motor). FLEXIBILITY (Quickset Cycle Control puts press cycling at your fingertips. Wide range of closing speeds to meet requirement. Readily adapted to semi-automatic operation.) SAFETY (Sequence safety interlock protects operator, mold and machine). Sizes 50 to 300 tons.



COMPLETELY AUTOMATIC TRANSFER MODELS

Newest Hull-Standard Press—now available after eight years' design development and proven production performance. Compact design, completely automatic, especially suited to economical molding of small parts demanded by miniaturization in electric and electronic components. Makes possible closer tolerances and more fragile parts. Minimizes flash and finishing costs—particularly on parts with through holes. Model 99-A available, 15 tons clamping capacity.



SEMI-AUTOMATIC COMPRESSION and TRANSFER MODELS

A great money-maker as proved in over 500 molding plants. High speed, semi-automatic. First cost, operating cost and maintenance cost are all *low*. Many exclusive features. Sizes from 50 to 300 tons in compression and transfer types. Write for new brochure.

over 20 years of service to the Plastics Industry

HULL-STANDARD CORPORATION
ABINGTON, PENNA.

EMMETT MACHINE & MANUFACTURING INC.

Now Taylor's international Field many versatile Individual Instruments or

WHAT THIS MEANS TO YOU. The name of the new subsidiary company is Taylor-Emmett Controls, Inc. This means that the products of Taylor-Emmett will now be sold by the Taylor Instrument Companies' sales organization, backed by industry-wide experience of Taylor application and design engineers and full facilities of Taylor research. Emmett instruments have earned a fine reputation in the plastics and rubber industries. They incorporate great engineering ingenuity in their compactness, interchangeability of parts permitting small inventories and their simplified construction. The fact that they are now available through your Taylor Field Engineer will mean experienced help on your processing problems and prompt service when required. Write for catalog to Taylor-Emmett Controls, Inc., Akron, Ohio, or Taylor Instrument Companies, Rochester, N. Y.



Mastertrol Control Center for timing and bumping, is a centralized unit for controlling the operation of 16 molding presses, including spare plug-in unit and test station. Puts quality control in the hands of supervision, independent of the whims of individual operators.



Type D765 Robotron Timer —the complete timing control for plastic molding presses. Panel is so simple that any possible cycle sequence can be set up in as short a time as 10 seconds, without particular skill or familiarity.

Two Pressure Fully Balanced Automatic Hydraulic Valves. "Never-Grind" Construction, cylinder-operated. 35 to 100 psi. Adjustable speed check for L.P. 75 to 1,000 and H.P. 4,000 to 6,000 psi. Sizes ¾ through 4". Normally Open; Normally Closed and 3 Way Fully Balanced.

Diaphragm Operated Valves. Air-operated. High capacity in Normally Open, Normally Closed, 3-Way and Normally Open V-Port types. Pressures to 300 psi. Bronze, cast-iron or steel bodies. Any trim. Also available with cylinder operators.

3500-lb. Three Way Valve. Type 380 balanced Three-Way Hydraulic Valve is cylinder operated, compact and has a high capacity. Pressure may be applied to any port connection, due to the valve's balanced design. "Never grind" feature. 35 to 100 psi. air pressure.

3500-lb. Two Way Valve. Type 370 balanced Two-Way Hydraulic Valve is cylinder operated, compact and has excellent capacity. Available either normally open, or normally closed. Normally operated at 35 to 100 psi, air pressure.









MERIT

Taylor-Emmett Controls, Inc.

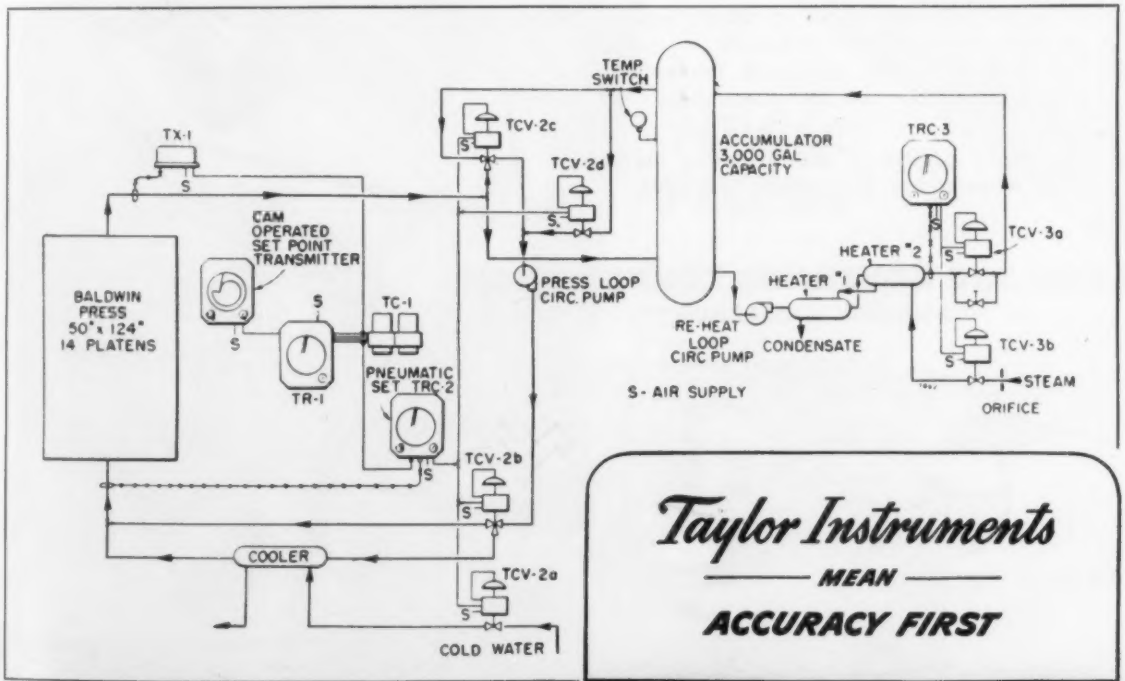
A SUBSIDIARY OF *Taylor Instrument Companies*

BECOMES PART OF **TAYLOR INSTRUMENT COMPANIES**

Engineer organization will provide completely coordinated Control Systems

PRODUCING high quality laminated plastic sheets demands a safe, dependable, and fully controllable heating and cooling system. A well-known Eastern company has solved this problem with the use of a fully automatic system, using Taylor controls. See schematic below.

Maybe your control problem is different from this one, but here is an interesting example of successful cooperation between user, equipment manufacturer, and instrument engineer. When you buy Taylor instrumentation, you're also buying years of experience and technical skill, that pays off in greater quality control and lower operating costs. For further information, see your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester 1, N. Y., or Toronto, Canada.



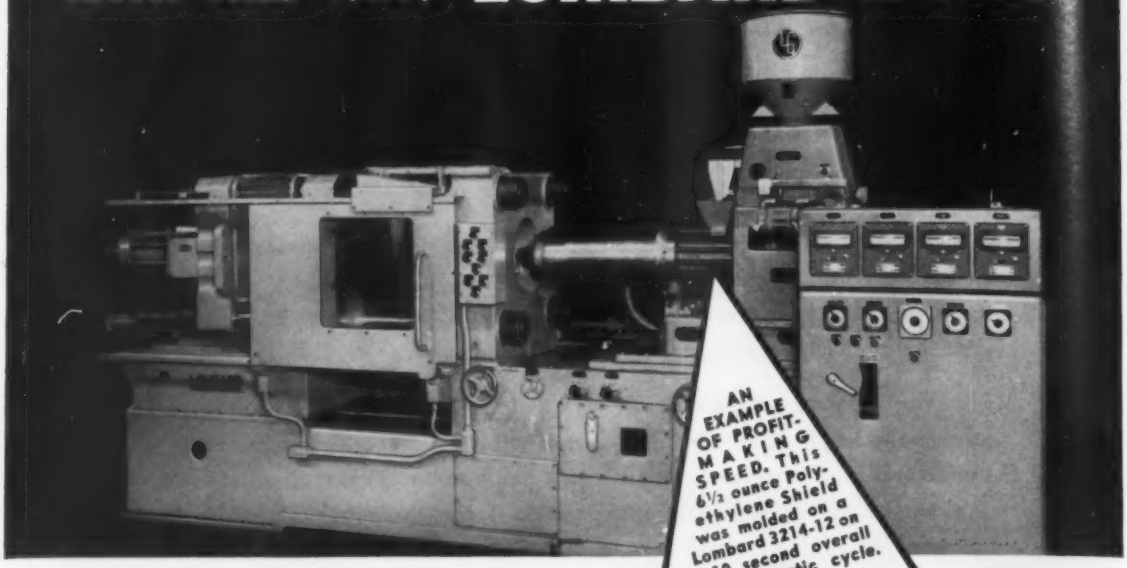
Fully automatic heating and cooling system provides for low peak demand on steam supply, and enough reserve heat storage capacity to carry one complete press cycle.

Taylor Instruments
MEAN
ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY

SPEED! SPEED! SPEED!

WITH THIS *NEW* LOMBARD 12 OUNCE



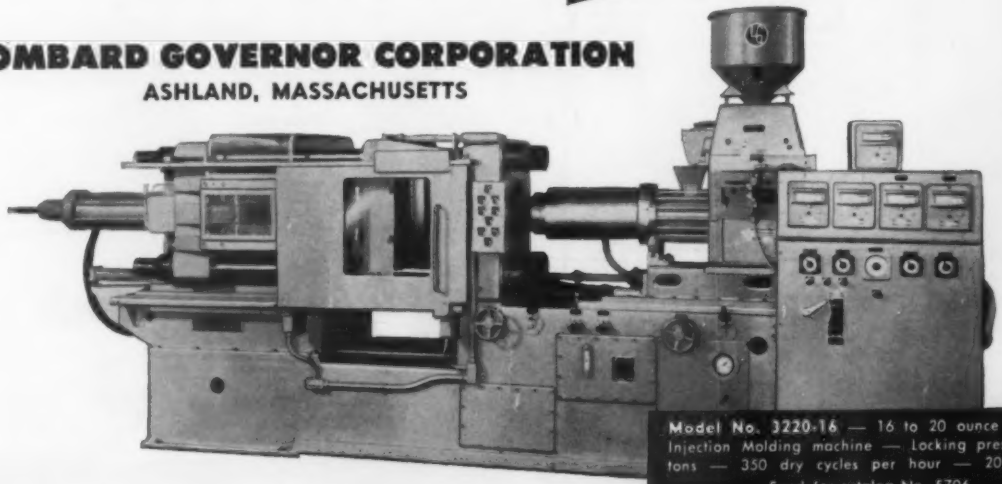
AN EXAMPLE OF PROFIT-MAKING SPEED. This 6½ ounce Polyethylene Shield was molded on a Lombard 3214-12 on a 10 second overall semi-automatic cycle.



Model 3214-12 provides greater locking pressure at 438 tons than any similar 12 ounce machine offered today. This greater pressure prevents flashing; makes larger casting area possible. These features combined with a speed of *420 dry cycles per hour assure production at a profit* . . . . . Weigh Feed is standard equipment. This model is available with 20" platen stroke.

For many additional and exclusive features, write today for Catalog No. 5742.

LOMBARD GOVERNOR CORPORATION
ASHLAND, MASSACHUSETTS



Model No. 3220-16 — 16 to 20 ounce Lombard Injection Molding machine — Locking pressure 438 tons — 350 dry cycles per hour — 20" stroke.
Send for catalog No. 5706



SQUARING SHEARS

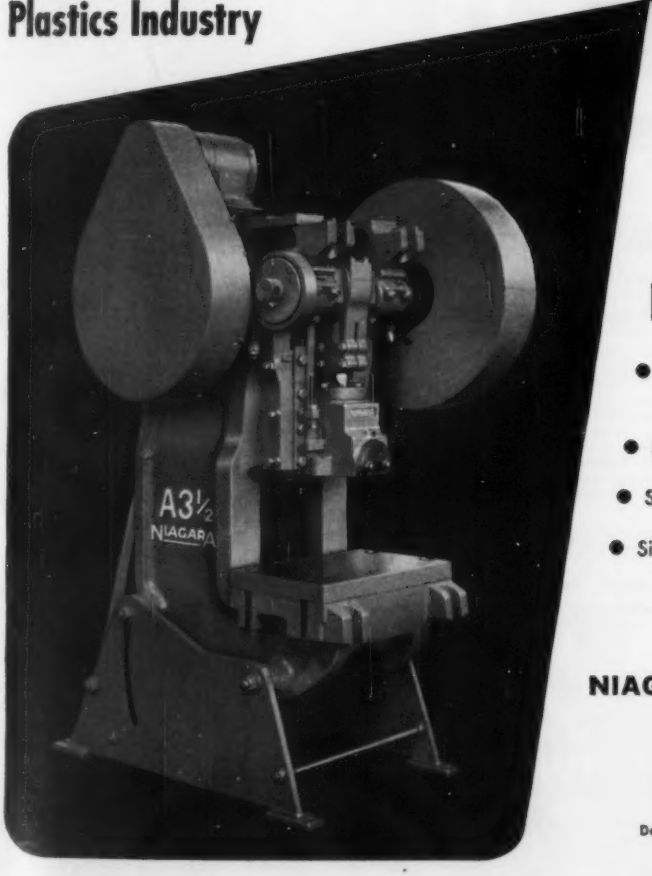
- Widest range of capacities and cutting lengths.
- Foot operated.
- Air operated.
- Power operated (underdrive and overdrive).

Shear and Press Selection Made Easy for the Plastics Industry

ONE SOURCE

NIAGARA

FOR COMPLETE DIVERSIFIED LINES



POWER PRESSES

- Widest range of capacities and sizes.
- Single and Double Crank O.B.I.
- Single and Double Crank Gap Frame.
- Single and Double Crank Straight Side.

Write for Bulletins

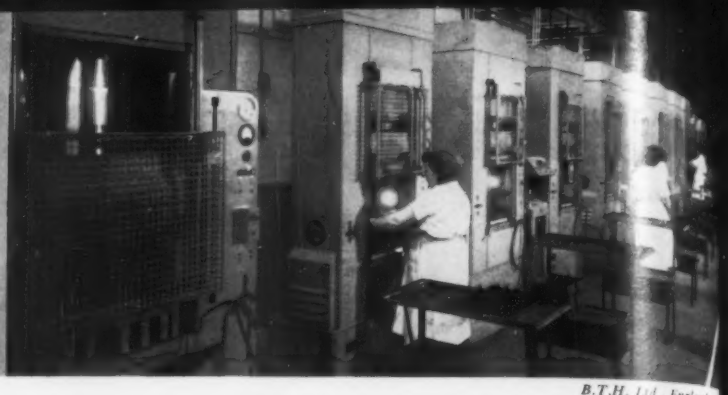
NIAGARA MACHINE & TOOL WORKS
Buffalo 11, N. Y.

DISTRICT OFFICES:
Buffalo • Cleveland • Detroit • Indianapolis
New York • Philadelphia

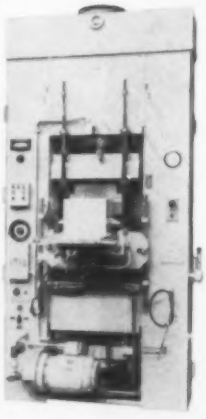
Dealers in Principal U.S. Cities and Major Foreign Countries

Compression–Transfer Presses

Users report up to 20% higher production with a Bipel Press installation! "Auto-Control" replaces hit-and-miss judgment, permits use of semi-skilled labor with more cycles, almost no rejects!



B.T.H. Ltd., England

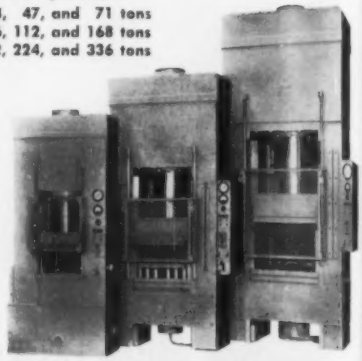


***FEATURES:* Fewer Rejects** . . . "Auto-Control" reproduces even the most complex molding cycle, including provision for breathing and dwell. Production of usable pieces usually 100%. **High Output** . . . operator merely loads preform, presses button. Automatic control eliminates time lost clearing over-cured moldings, cuts stripping and reloading time (especially for small multicavity components). Result: several extra cycles per hour. **Low Maintenance** . . . mold pin breakage reduced because of slow closing speeds. Special unloading valve which cannot bypass fluid under pressure, but always unloads, safeguards hydraulic system. Basic operating pressure of only 1000 psi, saves wear and tear, with pressure doubled or tripled *within* the press. **Drive Systems** . . . central, out-of-the-way system for multiple installations, or built-in for individual presses. **Close Temperature Control** . . . induction heated platens (available for your present presses, too) mean closer control and more effective heat transfer to work. **Choice of Pressures** . . . 3 sizes available.

BRAND NEW FULLY AUTOMATIC PRESS *(left)* occupies only half the usual floor space! Very fast feeding and stripping action; easy changeover from top to bottom ejection, automatic to manual operation. Automatic units swing to side for free access to molds. 2 models available with up to 71 or 168 ton capacities.

BIPEL Presses available in 3 models, each offering a selection of 3 pressures:

TYPE 40: 23, 47, and 71 tons
TYPE 100: 56, 112, and 168 tons
TYPE 200: 112, 224, and 336 tons



B.I.P. ENGINEERING LTD.
Sutton Coldfield, England

In Canada: John Sperling and Company
[illegible]

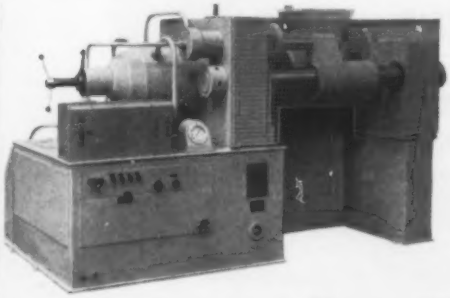
BIPEL®

AMERICAN INQUIRIES TO:
RALPH B. SYMONS ASSOCIATES, INC.
[illegible]

***FEATURES:* Uniform Density** . . . die rides free during compression, allowing equivalent pressure on *both* punches. This, plus accurate hydraulic loading, insures constant uniform density. **Preforms Any Powder** . . . main ram compresses powder only, with *steady squeeze*, not mechanical blow. Complete control for amount of "dwell" or pressure desired.

maximum pressure	13 tons	39 tons	78 tons	155 tons
maximum strokes per hour	2600	1500	850	600
typical preform weight	.2–1.2 oz. (1½" dia.)	3.7–8.1 oz. (3" dia.)	8.3–18 oz. (4½" dia.)	10 oz.–6 lbs. (6½" dia.)

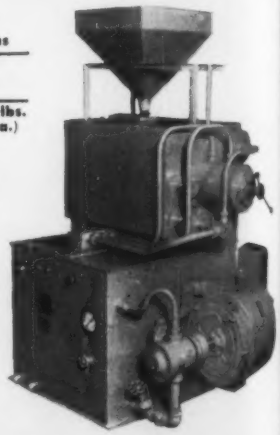
*based on average powder density of .35 ozs. per cubic in.



M.K. Electric Ltd., England

Double pressing arrangement available to allow for escape of air in preforming difficult powders. **Damage-proof Operation** . . . no moving parts come between punches. **Clean, Quiet** . . . fills from *within* hopper for dust-free, quiet operation; can be cleaned in minutes between runs. **Labor Saving** . . . finished preforms are so firm that they may be discharged into tote boxes or drums unattended. One operator can easily supervise several units. **No Powder Loss** . . . all powder is preformed, no spillage. **Higher Production Rate** . . . from multiple punch sets; punches for special shapes available. **Controls** of all operating variables located conveniently for instant settings. **Service** . . . all normal replacement parts in stock for immediate shipment if needed. Electricals to suit.

155 TON UNIT *(left)* has 7½ inch fill depth, can produce large preforms up to 6½ lbs., handle a ton of material per hour.



Write for complete details. Demonstrations and Full Service at Tiverton.



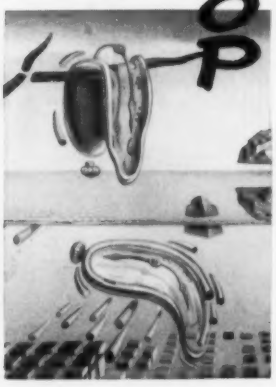
Controlled hydraulic operation with high production speeds are possible only with Bipel! Unmatched versatility, performance and speed . . . clean and quiet . . . Bipel Preformers can produce preforms up to 6 lbs. ea., or small preforms up to 25,000 per hour!

Horizontal Hydraulic Pelleters

INJECTION MOLDERS
DON'T LET YOUR MOLDING PROFITS DROOP

STOP LOSING TIME WITH OLD STYLE HEATERS





Here's What IMS REPLACEMENT HEATING CYLINDERS *Will Do for You*

PROVEN IN USE

These inside glimpses of IMS cylinder design explain why more and more molders are replacing old cylinders with IMS Heating Chambers.

IMS Extra Capacity Heaters bring down molding and maintenance costs. Reeds, Watsons, HPM's, Impco, Fellows and many other machines -- over 700 in all -- in sizes from 4 to 85 ounces, are now equipped with IMS Long-Life Superheaters.

SIMPLICITY IN CONSTRUCTION

Our three heater sections (front, spreader and rear) require a minimum of critical tolerances. Ample seat area is used, but seats are not so wide as to spread the available load too thin. Perfect registers, self-reenforcing overlap at joints, with correct crown on seat are the secret of IMS leakproof seals.

There are no sleeves -- no gaps -- no press fits to interfere with uniform heat transfer, or to expand unevenly, causing leaks or hot spots.

STREAMLINED DESIGN

Integral Spreader Unit permits maximum internal streamlining consistent with elimination of sharp fins or points where burning can occur. Uniform flow through IMS Heaters is assured because all internal sections are designed to pass material evenly -- no place for plastic to stick or lag. Heated spreader unit is the most efficient plasticizer commercially available today!

LEAKPROOF WELDS

IMS uses a special HOOK JOINT weld that locks the cylinders together far tighter than is possible with bolts or threads. Our Hook Joint holds better because it is located closer to the seat area than any other fastening method, and eliminates most of the leverage that starts leaks in other cylinders.

CUTS REPAIR COSTS

Repair costs are usually one-half to one-third less than with other cylinder types. And cylinder life is usually from 2 to 5 times that of most original equipment units. Year in, year out your downtime is less with IMS Leak-Proof Replacement Cylinders.

There's New Profit in Old Presses with IMS Extra Capacity Superheaters

WRITE TODAY!

INJECTION MOLDERS SUPPLY CO.

3514 LEE ROAD • WYoming 1-1424 • CLEVELAND 20, OHIO

IMS

COATING AND HANDLING SYSTEMS

for

TEXTILES • PAPERS • FILMS • FOILS

ROLLEVATOR® OVENS

For the maintenance of constant heat exposure in web treating systems regardless of changes in line speeds, including stoppage.

PLASTISOL COATING SYSTEMS

The application of high solid vinyls to webs is accomplished with IOI integral coating, fusing and embossing systems for producing a multitude of end products.

ORGANOSOL COATING SYSTEMS

These IOI systems apply organosol dispersions in volatile solvents to webs at high production rates to produce artificial leathers, pressure sensitive tapes, book cover cloths, etc.

HYDRASOL COATING SYSTEMS

For the application of water dispersions of various resins, such as vinyls, rubbers or neoprenes, to various webs for such uses as paper backup for tapes, decorative papers or industrial fabrics.

IMPREGNATION SYSTEMS

For the continuous saturation and impregnation of one or several webs under complete process control using polyesters, latices, varnishes and silicones—for many important industrial products.

SILICONE CURING OVENS

Batch or continuous operation with silicone rubbers or resins for molded, extruded or coating applications.

Write for descriptive literature, specifications and complete detailed information

INDUSTRIAL OVENS, INC.

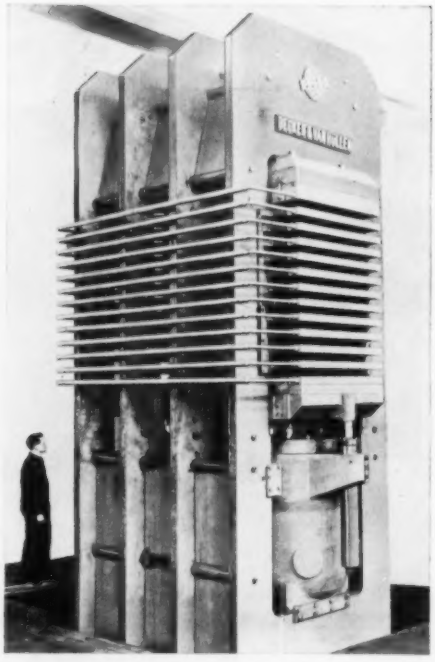
13817 TRISKETT ROAD CLEVELAND 11, OHIO

FOR PRODUCTION . . . FOR ECONOMY

LAMINATING PRESSES

by

BECKER & VAN HÜLLEN



• This steel frame press, shown on the factory assembly floor, is the third such unit for the manufacture of high pressure decorative laminates installed at Pioneer Plastics Corp., Sanford, Maine. Like every other Becker & van Hüllen press, it is *assembled and operated* before being knocked down for shipping.

Becker & van Hüllen presses run from small laboratory models for pilot operation to gigantic units featuring fully automatic operation. Whatever your requirements are, Becker & van Hüllen has a laminating or compression press with the features you want. Let us know what sizes, pressures and operating conditions interest you. We will send complete data.

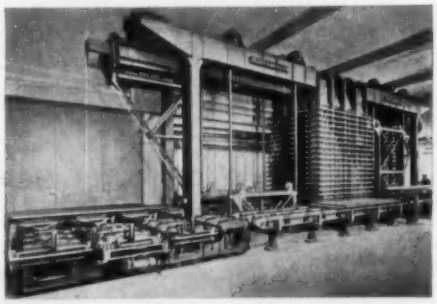
- **laminating presses**
- **compression presses**
- **transfer presses**
- **injection molding machines**

Sole U. S. Representative:

KARLTON MACHINERY CORPORATION

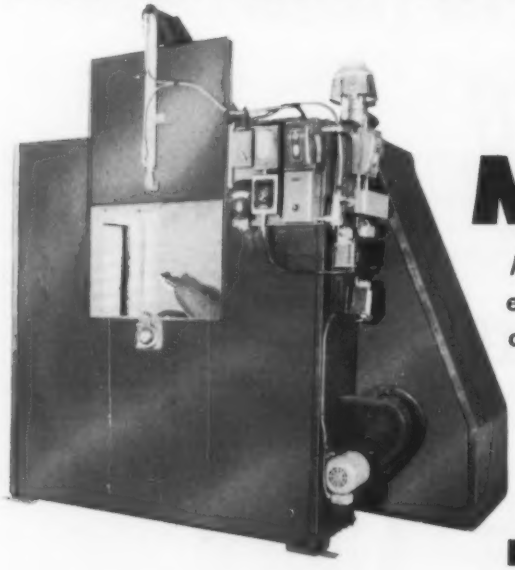
210 E. Ohio St., Chicago 11, Ill.

A completely automatic Becker & van Hüllen installation . . . automatic loading, unloading and sheet handling.



BECKER & VAN HÜLLEN / KREFELD
WEST GERMANY

To Seek Solutions to your
PLASTISOL MOLDING PROBLEMS



See -
MERCURY

Manufacturers of specifically designed equipment for molding vinyl plastisols and other related plastics.

Mercury "Roto-Molder"
Model SD-2 for
rotational plastisol casting

MERCURY
MOLDING MACHINERY INC.
972 NEPPERHAN AVE., YONKERS, N.Y.
YONKERS 3-8676

Auxiliary Equipment For Vinyl Plastics Molding

1. Dispensing Equipment
2. Conveyorized Ovens
3. Cooling Systems
4. Vacuum Stripping Units
5. Conveyorized Layouts
6. Spinning Equipment
7. Stripping Tables

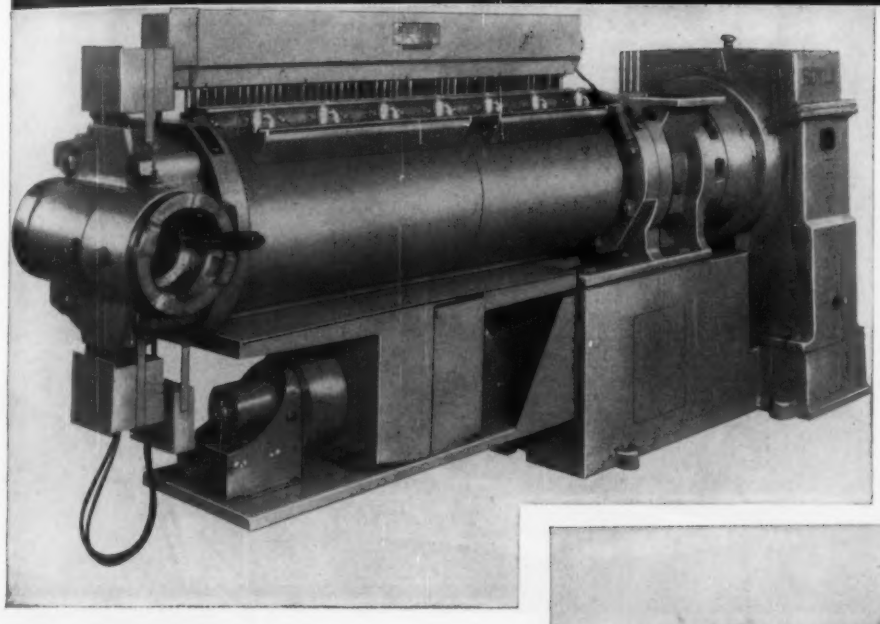
MADE BY THE MANUFACTURERS OF THE NATIONALLY KNOWN RED HEAD CONVEYOR PULLEYS AND PREFAB CONVEYORS.

MERCURY INDUSTRIES INC.
HILLSDALE, NEW JERSEY
Vinyl Plastics Equipment Division

WESTWOOD 5-2636

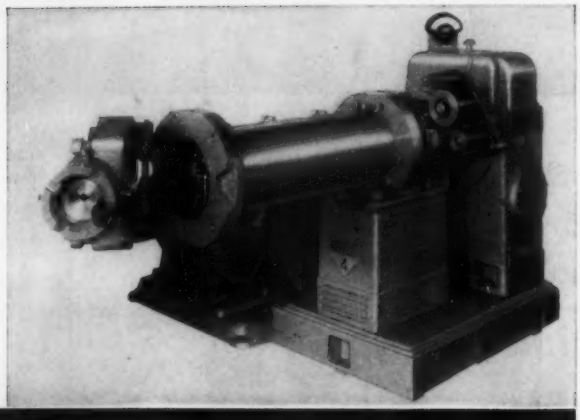
ROYLE EXTRUDERS for RUBBER, PLASTICS, WIRE INSULATING

Dependable, economical, 'round-the-clock production is assured with Spirod or Spiroyle extruding machines. They are the result of more than three-quarters of a century's experience in the design and construction of extruding machines in which time-tested features have been incorporated to provide maximum productivity with minimum operating cost.



SPIROD®

an electrically heated extruding machine with high velocity evaporative cooling. Although designed to supply and hold the accurately zoned higher temperatures required in processing today's plastic compounds, Spirod is an all-purpose extruding machine for either rubber or plastics.



SPIROYLE® extruding machines designed for processing where the use of a circulating heat transfer medium is desired for sensitive operating temperatures.

Both SPIROD and SPIROYLE extruding machines are available in standard sizes—1⅛" through 12" cylinder bore.

Write for Bulletin #463

JOHN ROYLE & SONS

ROYLE PATERSON N. J. 1880

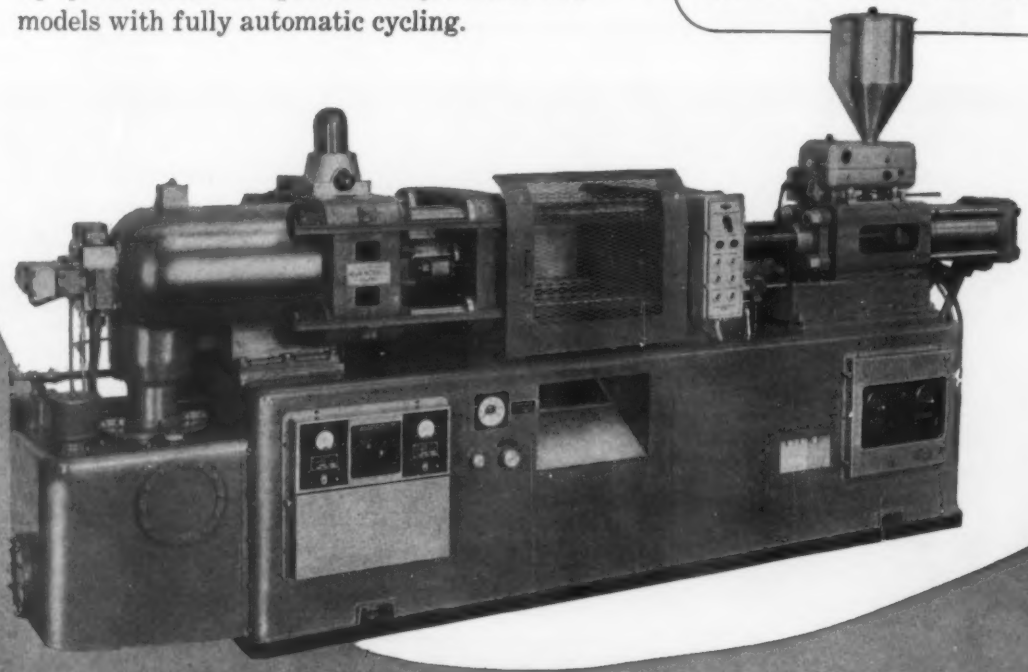
PIONEERED THE CONTINUOUS EXTRUSION PROCESS IN

London, England	Home Office	Akron, Ohio	Los Angeles, Cal.	Tokyo, Japan
James Day (Machinery) Ltd.	V. M. Hovey J. W. VanRiper	J. C. Clinefelter Co.	H. M. Royal, Inc.	Okura Trading Co., Ltd.
Hyde Park 2430 - 0456	SHerwood 2-8262	BLackstone 3-9222	LUdlow 9-3261	(56) 2130 - 2149

AUTOMATION

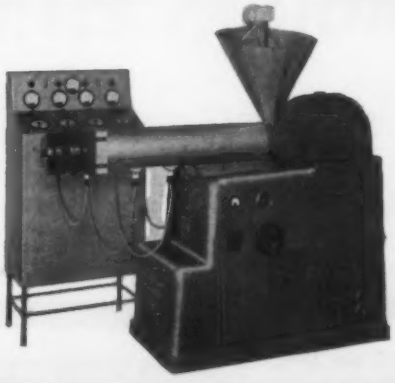
This is the age of automation and Negri Bossi automatic machines lead the way. Negri Bossi equipment features special safety devices and models with fully automatic cycling.

R. 12 F.A. Fully automatic injection press – capacity 4 to 6 oz. – fast operating cycles (8 shots a minute)





VUOTOPLAST Vacuum Forming Machines



EXTRUDERS and accessory equipment

Sole distributors:

Write for further information

U.S.A.—Acme Machinery & Manufacturing Co., Inc.
102 Grove Street, Worcester, Mass.
Phone: PLeasant 7-7747

New York Office: 2315 Broadway
Phone: SUsquehanna 7-1705

Canada—Plastics Equipment & Accessories
1362 Jean Talon Est.
Montreal 35, P.Q.
Phone: CRescent 4-8274

NB&C **NEGRI BOSSI & CO., MILANO (ITALY)**

Corso Magenta, 44

Cable address: Gianimar

Thermatron*

*Reg. U. S. Pat. Off.

Industrial Electronic Generators and Heat Sealing Presses

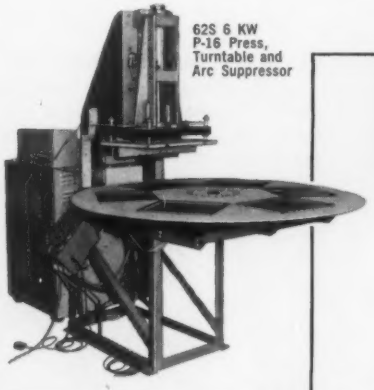
Electronic welding of vinyl plastics by Thermatron is rapidly replacing older, less satisfactory methods throughout the world. The dynamic force developed in these generators *welds* – does not stitch – plastic in seconds, to produce seams stronger than the material itself . . . air-tight and water-tight.

Standard electronic generators and presses from ½ KW up to 500 KW can be supplied with almost any degree of automation desired to weld vinyl from .002" to .080" as well as plastic foam, quilted vinyl sheeting and other special materials. Also available are completely automatic feeds incorporating turntables and conveyor systems so that the plastic may be welded, cut and embossed in a single operation.

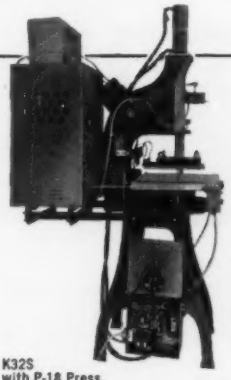
Thermatron units are sold under one contract and one responsibility, which covers survey, generator, press, electrodes and their installation. Presses of custom design and electrodes built to order for special requirements. A few of the many models available are illustrated. For further information, write for our latest bulletin MP.



50 KW Thermatron Generator



62S 6 KW P-16 Press, Turntable and Arc Suppressor



K32S with P-18 Press, Arc Suppressor and exposed safety system

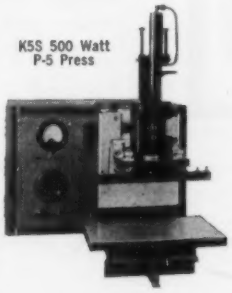


K20H 2 KW Heater with Oven

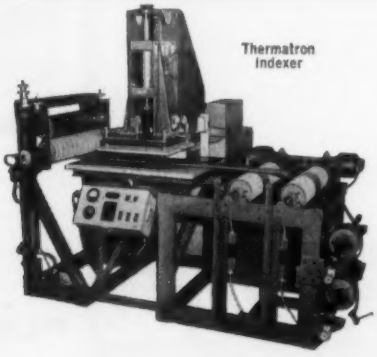
Welds– doesn't stitch...

Inflatable toys	Dress forms
Handbags	Quilted seat covers
Raincoats	Upholstery
Wallets	Drum liners
Place mats	Safety clothing
Shower curtains	Welting
Luggage	Bags for packaging

. . . and many others including special products for the automotive industry



K5S 500 Watt P-5 Press



Thermatron Indexer

Thermatron Division

RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

SALES OFFICES: 251 West 19th St., New York 11, N. Y. WAtkins 4-3633
Chicago: 2753 West North Ave., Los Angeles 22: R.A. Sperr, P.O. Box 6878
St. Louis 19, Mo.: R.E. Fisler, 225 Baker Ave., Webster Groves·Factories in Brooklyn, N. Y.

RADIO & ELECTRONIC
RR
PRODUCTS SINCE 1922

Extruders:

BEFORE YOUR JOB



Robbins Combination Haul-Off & Shear Unit

This unit can be combined as shown, or the chromium roll and rubber roll can be mounted on individual bases for positioning that best fits your needs. Can be used with all makes of extruders now on the market.

Robbins Dies

Robbins produce dies for all types of extrusions. The one illustrated was engineered for rigid materials and within 3½ hours after the initial start up it was producing a quality product.

Sheet Polishing Unit

This Robbins Sheet Polishing unit helps you three ways: (1) More uniform product—eliminates wrinkle and pit holes. (2) Retains finish after vacuum forming. (3) Cuts costs.

Robbins
never say die . . . say Robbins die

PLASTIC MACHINERY CORPORATION

We specialize in the design and building of special type dies and haul-off equipment for the plastic extrusion field

GOES ON THE BOARD...

...let our "board" go to work for you



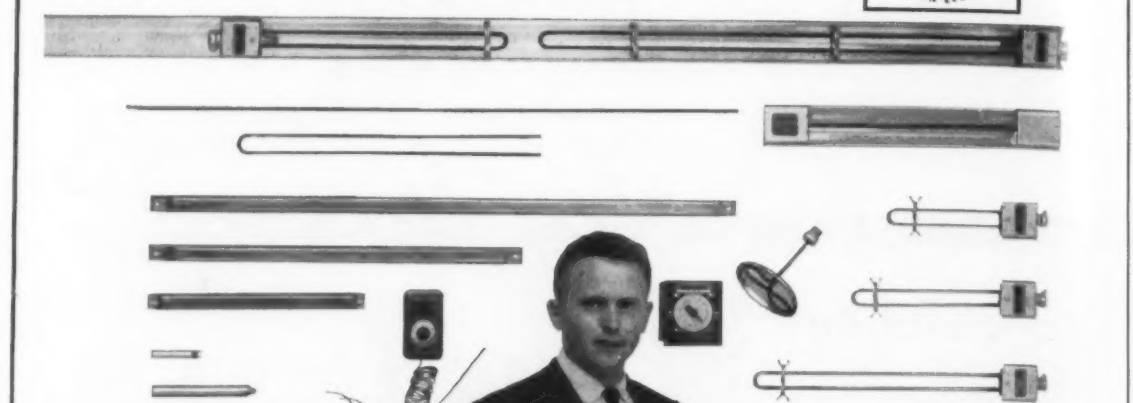


Not miracle men... but a capable group with imagination, creative drive and practical experience who specialize in the production of dies, haul-off and other special equipment for the plastic industry. Simply, here is ability... ability that can be of invaluable help to you in this highly specialized field. *Use it!*

Robbins standard line of equipment includes: sheeting dies • haul-off rolls • traveling shears • wind-up units • pipe dies • water tanks • pipe pull-offs • pipe coiling machines • traveling cut-off saws • profile dies • conveyors • splicing machines • cut-off machines.

1430 MISHAWAKA STREET • ELKHART, INDIANA • TELEPHONE 2-4060

Want quick, economical solutions to your heating problems?



Call the Chromalox man for the **ANSWERS**

No matter what heating problem you have, there's a Chromalox electric heating unit of the type and size you need.

Your Chromalox Representative—the man with the answers to your heating problems, routine or unusual—can provide you with the plastic industry's only complete heating line.

Over 15,000 standard types, sizes, and ratings to choose from—plus a complete range of controls and accessories—give you the best answer for your specific job. For instance . . .

- With Chromalox Electric Far-Infrared, you get fast, uniform heat dialed to your exact need from 4 to 100% of heater capacity. The elements are metal-sheathed and unbreakable, and provide color-blind, uniform radiation.
- Easy to install strip heaters come in lengths up to 96 inches. Available curved lengthwise or in cross-section, as well as new half-circle, high-temperature refractory-insulated heater bands designed to clamp on injection and extrusion barrels.
- Chromalox Electric Cartridge Heaters provide more dependable spot heat with close thermal control. Exclusive design gives positive lead wire protection against flexing, abrasion, moisture.

For an on-the-spot heating analysis at no obligation, just call your Chromalox Direct Factory Representative. He is backed by Edwin L. Wiegand Company—the world's largest manufacturer of electric heating apparatus. A call to your "man with the answers" (see listing on opposite page) will put Chromalox Engineering Service to work for you.

C-2129

CHROMALOX Electric Heat

Edwin L. Wiegand Company

Department P, 7500 Thomas Boulevard, Pittsburgh 8, Pennsylvania · CHurchill 2-6400

Call Chromalox

for the man with the
ELECTRICAL ANSWERS
to your heating problems

ATLANTA 9, GA.
Applebee-Church, Inc.
1389 Peachtree St., N.E.
TRinity 5-7244

BALA-CYNWYD, PA.
J. V. Calhoun Co.
349 Montgomery Ave.
MOhawk 4-6113

BALTIMORE 18, MD.
Paul V. Renoff Co.
333 E. 25th St.
HOpkins 7-3280

BLOOMFIELD, N. J.
R. L. Faber & Associates, Inc.
1246 Broad Street
EDison 8-6900

BOSTON 11, MASS.
Leo C. Pelkus and Co., Inc.
683 Atlantic Ave.
Liberty 2-1941

BUFFALO 2, N. Y.
Niagara Electric Sales Co.
505 Delaware Avenue
SUmmer 4000

CHARLOTTE 2, N. C.
Ranson, Wallace & Co.
116½ East Fourth St.
EDison 4-4244
FRanklin 5-1044

CHATTANOOGA 1, TENN.
H. R. Miles and Associates
P. O. Box 172
Phone 5-3852

CHICAGO 6, ILL.
Fred I. Tourtelot Co.
407 S. Dearborn Street
HArrison 7-5507

CINCINNATI 8, OHIO
The Smysor Company
1046 Delta Avenue
TRinity 1-0605

CLEARWATER, FLA.
J. J. Galleher
617 Cleveland Street
P. O. Box 1376
Phone 3-7706

CLEVELAND 13, OHIO
Anderson-Bolds, Inc.
2012 W. 25th Street
PRospect 1-7112

DALLAS 26, TEXAS
L. R. Ward Company
3009-11 Canton Street
Riverside 1-6279

DAVENPORT, IOWA
Volco Company
215 Kahl Bldg.
Phone: 3-2144

DENVER 2, COLO.
E. & M. Equipment Co.
2415 15th Street
GLendale 5-3651
GEnesee 3-0821

DES MOINES 14, IOWA
Midwest Equip. Co. of Iowa
842 Fifth Avenue
CHerry 3-1203

DETROIT 38, MICH.
Carman Adams, Inc.
15760 James Couzens Hwy.
UNiversity 3-9100

HOUSTON 3, TEXAS
L. R. Ward Company
3605 Polk Street
CApitol 5-0356

INDIANAPOLIS 4, IND.
Couchman-Conant, Inc.
627-631 Architects & Builders Bldg.
MElrose 5-5313

KANSAS CITY 6, MO.
Fraser D. Moore Co.
106 E. 14th Street
Victor 2-3306

LOS ANGELES 15, CALIF.
Montgomery Brothers
1053 South Olive Street
RIchmond 7-9401

MIDDLETOWN, CONN.
Dittman and Greer, Inc.
33 Pleasant Street
Diamond 6-9606

MILWAUKEE 3, WIS.
Gordon Hatch Co., Inc.
531 W. Wisconsin Avenue
BRoadway 1-3021

MINNEAPOLIS 4, MINN.
Volco Company
831 South Sixth Street
FEderal 6-3373

NASHVILLE 4, TENN.
H. R. Miles and Associates
2508 Franklin Road
CYpress 2-7016

NEW YORK CITY, N. Y.
See "Bloomfield, N. J."
WOrth 4-2990

OMAHA 2, NEB.
Midwest Equipment Co. of Omaha
1614 Izard Street
Atlantic 7600

PHILADELPHIA, PA.
See "Bala-Cynwyd, Pa."
GReenwood 3-4477

PITTSBURGH 6, PA.
Woessner-McKnight Co.
1310 Highland Bldg.
115 S. Highland Avenue
EMerson 1-2900

PORTLAND 9, ORE.
Montgomery Brothers
1632 N.W. Johnson Street
CApitol 3-4197

RICHMOND 26, VA.
(Branch, Charlotte)
Phone 88-8758

ROCHESTER 4, N. Y.
Niagara Electric Sales Co.
133 Clinton Avenue, South
HAmilton 6-2070

ST. LOUIS 1, MO.
C. B. Fall Company
317 North 11th Street
CHestnut 1-2433

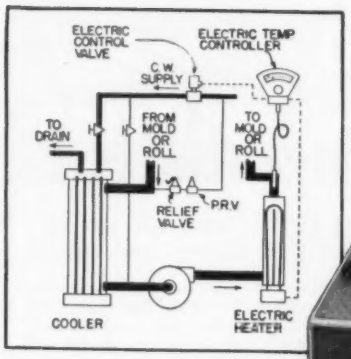
SAN FRANCISCO 3, CALIF.
Montgomery Brothers
1122 Howard Street
UNderhill 1-3527

SEATTLE 4, WASH.
Montgomery Brothers
911 Western Avenue
SEneca 3270

SYRACUSE 6, N. Y.
R. P. Smith Co., Inc.
2507 James Street
HOward 3-2748

WICHITA 2, KANS.
Fraser D. Moore Co.
Room 211 Derby Building
352 N. Broadway
AMherst 2-5647





Schematic sketch of the control circuit in the Sarcotrol Model MC-1, Single Unit. Model MC-2, Dual Unit, is equipped with two of these circuits, MC-3 has 3 circuits.



Before you buy...Compare
all Temperature Control Units for molds, rolls, cylinders, drums

COMPLETELY redesigned, the new *Sarcotrol* heating and cooling unit is fully automatic as shown in the following list of features. It maintains even face temperatures by recirculating temperature-controlled water at high velocity through molds or roll jackets. Check *Sarcotrol's* features against any other unit *before* you buy.

Sarcotrol gives you *all* these features

- **Dependability** — built and guaranteed by Sarco, makers of temperature controls and steam traps since 1914.
- **No need for special heat transfer liquids** — temperature-controlled water to 300° F. is recirculated at high velocity in closed system.
- **Independent circulating systems** — the Sarcotrol is available with one, two or three independent systems (see above sketch).
- **Simple, sensitive control** — one knob changes temperature control setting; sensitive thermostat (±1°) minimizes temperature lags; easy-to-read dial shows both desired and actual temperatures.
- **Automatic selection of heating rate** — for fast heat-up; then close control.
- **Saves electricity and water** — the *same* thermostat regulates both *rate* of heat input and cooling; cuts out both when set temperature is reached.
- **Automatic heater protection** — heaters are automatically cut off when pump is shut down.
- **Many other features** — are listed in the *Sarcotrol* technical bulletin.

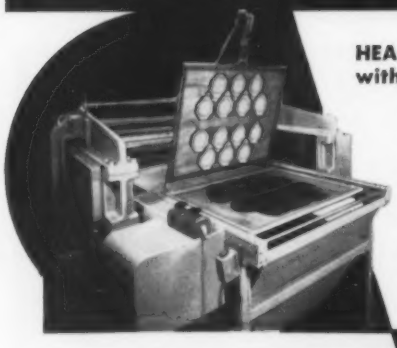
2178 F

Please advise if you are interested in automatic temperature control for molds or for rolls. Technical bulletin and case histories will be mailed to you by Sarco Company, Inc., Empire State Building, New York 1, N. Y.

SARCO

Improves product quality and output

DEPEND on FEMCO *for the BEST*
DIE CUTTERS AND SPLITTERS



HEAVY DUTY ROLLER DIE CUTTER with AUTOMATIC Load and Unload

Fully loaded frame and dies automatically move onto bed of Die Cutter; parts are die cut; frame and dies move off bed; die cut parts drop into hopper and tote box. Equipment fits FEMCO Roller Die Machines with bed sizes 48 x 42; 48 x 72; 48 x 84. Designed for continuous production trimming of molded rubber goods and small automotive parts.

Single Head AUTOMATIC LEVELING and SPLITTING MACHINE

For Polyurethane, Polyvinyl Foam and similar Plastic Foam materials. This automatic machine requires only one operator, man or woman. Levels slabs 12" high, then reduces slab to sheets thin as ⅛", thick as 2".

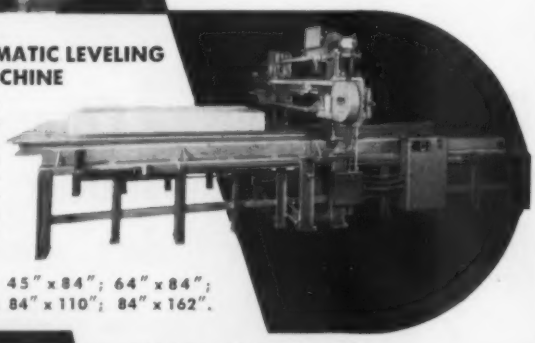
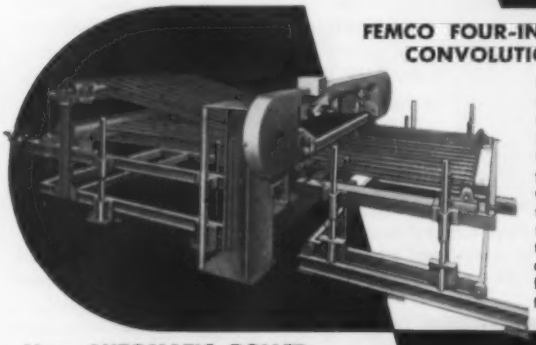


Table sizes: 45" x 64"; 45" x 84"; 64" x 84"; 64" x 96"; 64" x 110"; 84" x 110"; 84" x 162".

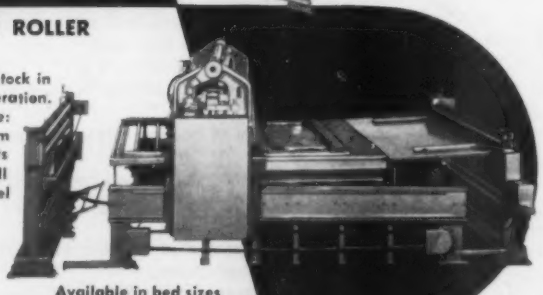
FEMCO FOUR-IN-ONE CONVOLUTION MACHINE

Combines features of Cushion Cutter, Models 65-78 Splitter and single head conveyorized Slab Cutter; also makes corrugated cuts of Polyvinyl and Polyurethane stock, slabs or rolls. Levels and splits slabs (max. 15" thick) into sheets as thin as ⅛". Handles slabs 9 ft. long. Splits roll stock thin as ⅛".



New AUTOMATIC ROLLER DIE CUTTER

Die Cuts parts from roll stock in automatic continuous operation. High production. Example: This machine has cut foam rubber cloth-backed parts 25 per minute from roll stock, using a 6 cavity steel rule die. Push button, machine automatically operates until entire roll of stock is die cut.



Available in bed sizes 72 x 66 and 84 x 72.

The FALLS ENGINEERING AND MACHINE CO.

Established 1917

1734 FRONT ST., CUYAHOGA FALLS, O.

FEMCO Builds 22 Special Machines for the Rubber, Plastics and allied industries. Write for folders, prices on machines shown here or inquire about others.

CAMBRIDGE SURFACE PYROMETERS for the PLASTICS INDUSTRY



♦ The routine use of Cambridge Surface Pyrometers takes the guesswork out of surface temperature determination. Cambridge Instruments are accurate, dependable, rugged, quick-acting and easy to use. The Roll Model is for checking surface temperatures of still and moving rolls. The Needle Model is for insertion into preforms and materials in a plastic or semi-plastic state. The Mold Model is for checking surface temperatures of mold cavities.

♦ For money-saving and better plastic-making suggestions, write for Bulletin 3528. It gives detailed information on these instruments.

CAMBRIDGE INSTRUMENT COMPANY, INC.

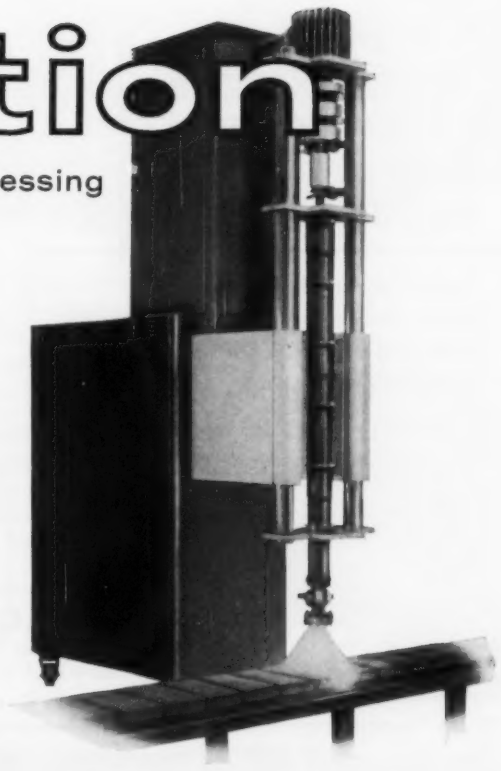
3528 Grand Central Terminal, New York 17, N.Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

Electron, X-ray or Neutron

radiation

for research or commercial processing



ARCO manufactures fully-developed, tested electron linear accelerators and positive ion accelerators, and also offers you comprehensive irradiation services and facilities. This service includes assistance in establishing irradiation facilities in your laboratory or plant and actual experimental investigation and processing in ARCO's Walnut Creek, California irradiation facility. Another irradiation facility is being built in Rockford, Illinois for the use of Eastern and Midwestern organizations.

At ARCO, your requirements will receive the attention of a widely experienced technical group—men whose professional careers have been devoted to research and production application of radiation.



NEW CATALOG GIVES DETAILS, APPLICATIONS

Write today for new catalogs describing ARCO accelerators and radiation service facilities.

ARCO Mark 1-F4 Electron Linear Accelerator

Brief Specifications - ARCO Accelerators

Electron Linear Accelerators	Mark I Series	Mark 20 Series
Electron Beam Energy	2 to 12 Mev	up to 50 Mev
Electron Beam Power	1 to 10 Kw	up to 60 Kw
Max. X-ray Intensity (1 meter)	1.2×10^6 rad/hr	10^8 rad/hr
Max. Fast Neutron Production	2×10^{12}/sec	10^{14}/sec
Max. Thermal Neutron Flux	10^9/cm²/sec	2×10^{11}/cm²/sec
Max. Capacity (100% Utilization Efficiency)	7,800 Mrad-lb/hr	47,000 Mrad-lb/hr
Max. One-side Penetration in H_2O (± 10% dose variation)	3.5 cm	

Positive Ion Accelerators	
High Current Neutron Generators	
Max. Beam Energy	500 Kv
Max. Beam Current	400 μa
Max. Neutron Yield (14 Mev - D-T reaction)	10^{11}/sec
High Energy Positive Ion Linear Accelerators to individual specifications	

ARCO APPLIED RADIATION CORPORATION

Walnut Creek, California, YEllowstone 5-2250 Cable "ARCO"

American Agile Fabricating Equipment Opens New Fields For Plastic Application

Complete PLASTIC WELDING KIT

"Do-It-Yourself" plastic welding kit permits fast, easy fabrication and repair of plastic components and weldments. Easy to use, the kit contains all necessary tools and supplies — 110-V. welding gun, 15′ nitrogen hose, Nitrogen flowmeter, contour marker, porosity spark tester, marking crayon, knife . . . plus, two simplified instruction books that guarantee successful welding.



Apply Corrosion-Resistant Plastic Coatings With The Fluidizing SPRAY & DIP COATING UNIT

This mobile, dual purpose unit called the Mark III, permits spray or dip coating of metal targets with corrosion-resistant coating using finely divided polyethylene powders. 33½″ high x 20″ wide, unit consists of metal reservoir, 15″ in dia. with 24″ deep powder bed. It is easily moved by one man and can be attached to any available compressed air line.

In addition to the application of polyethylene powder, the fluidizing process can be also used to apply nylon and fluorocarbons, thus increasing the flexibility of the unit.





Orders filled promptly from stock, or write for further information.

AMERICAN AGILE Corporation
5461 Dunham Road • Maple Heights, Ohio
(Suburb of Cleveland, Ohio)
Mail Address: P.O. Box 168, Bedford, Ohio

Reinforced Plastics



These presses are specially for polyester/glass or asbestos/phenolic or epoxy resins. The 250-ton press shown has a table size 8 ft. x 5 ft., daylight 8 ft. and stroke 4 ft. Vickers pumping equipment is mounted on the head and the rate of closing is adjustable down to very slow speed at any point desired on the stroke. The tables have tee slots for mould securing and are water cooled.

250-TON LOW PRESSURE PRESS

T. H. & J. DANIELS LTD.

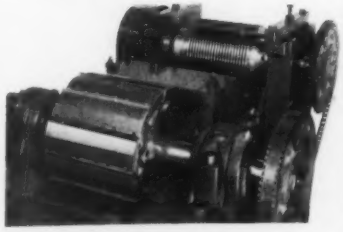
STROUD • GLOUCESTERSHIRE • ENGLAND

TAYLOR-STILES PELLETERS

CUT FROM 1/8th" CUBES
TO 5" x 5" x 1" BLANKS

●

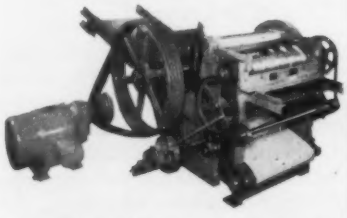
Cut up to 10 TONS of
PLASTIC PELLETS per hour!



Practically every plastic manufacturer of importance in the United States today is using Taylor-Stiles Cutters for dicing its stock. In some instances the material comes to the machine in a continuous sheet which may be up to 13½" wide. In other installations, the stock is in the form of rods which the 12 or 24 knife head of the Taylor-Stiles 700 Series Cutter shears off into pellets. Production rates on ⅛" cubes in some instances is as great as 10 tons an hour.

●

Cut 4648 —
5"x5"x1" SQUARES per MINUTE



A Taylor-Stiles #224 "LITTLE GIANT" Dicing cutter will cut 21" wide sheets into 5" wide strips and then cross cut these strips into 5" squares at the rate of 4648 squares per minute.

Other Taylor-Stiles Cutters are used for cutting latex.

●

JOB ENGINEERED KNIVES

Taylor-Stiles Knives keep their edge for amazingly long periods of time. When sharpening is necessary, the straight-edge design of Taylor-Stiles knives makes for quick and easy sharpening.

TAYLOR-STILES & CO.

13 Bridge Street
Riegelsville, N. J.

STROMES OVENS and DRYERS for the PLASTICS and CHEMICAL INDUSTRIES

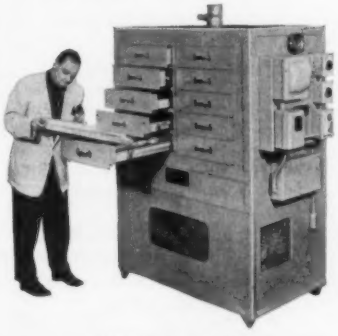
ELECTRIC · GAS · OIL · STEAM

PRECISE TEMPERATURE CONTROL
FORCED AIR CROSS-FLOW RECIRCULATION
ECONOMICAL • SAFE • DEPENDABLE



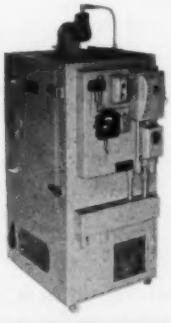
MODEL EBD SERIES

Single Row, Roller Bearing. Temperatures to 350° F Max. Preheating and/or refining plastic pounder and pellette for compression and injection molding processes and many other applications.



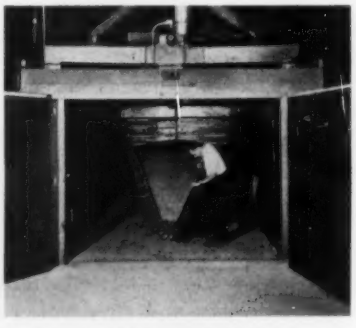
MODEL EID SERIES

Double Row, Roller Bearings. Insulated drawers front and rear. Available with wider single doors for plexiglass and other applications. Maximum temperatures to 600° F.



MODEL SBE SERIES

Applications: curing, baking, drying, testing, aging, pre-baking and sintering. Processes: Teflons, silicones, reinforced fiberglas, etc. Available with temperatures to 1100° F.



MODEL SFE SERIES

Curing polyester and fiberglas laminates and reinforced plastics on steel and plastic molds, etc., temperatures 100°-550° F. Available with temperatures to 1000° F.

Send for brochure of the STROMES SYSTEMS line of INDUSTRIAL OVENS.

STROMES SYSTEMS, INC.

"INDUSTRY IS OUR CAREER"

411 East 108th Street • New York 29, N. Y.

Selected territories available for sales representatives

Engineered to your present needs... Designed for your future expansion...

A FULL

To help you keep pace with the plastic industry's rapid expansion, Reed-Prentice carries on a continuing program of engineering research and development. As one result of this pioneering, the REED line is now the first offered by any manufacturer to bring you *both* injection molding *and* extrusion equipment.

Check this timetable and you will see why, over the last four years, eight REED engineering advances have pointed the way to faster, more economical production.

1953 – 450T – 20/24 oz. REED designed . . . rugged, fast, dependable.

1954 – 175T – 4/6 oz. REED . . . introduced for high-speed, automatic molding.
– 400T – 16/20 oz. REED . . . offered extra-capacity operation.

1955 – New REED-SPEED heater, with tapered spreader design, brought faster, more thorough plasticizing.
– 300TA-1/2/16 oz. REED . . . a complete redesign that helped slash molding costs.

1956 – New 275T – 8/10 oz. REED . . . with higher speed, more capacity, greater versatility.
– 600T – 32 oz. REED . . . new injection end design increased speed 72%.
– REED *Autoflow* marked the Reed-Prentice entry into extrusion with a revolutionary new principle of operation.

Backed by this record of leadership – every machine in the line either new or fully redesigned within the last four years – you can expect top value in a REED. Engineered into each of the six injection models you will find:

- **Versatility** . . . with positive mold clamping pressure that minimizes flash, adjustable mold clamping stroke, and provision for fully automatic operation.
- **Fast plasticizing** . . . REED-SPEED heater, standard on all machines, gives you top capacity and speed.
- **Ease of operation** . . . with centralized controls and hydraulic adjustment of die space and plunger housing.
- **Rugged construction** . . . because fabricated steel bases are built for extra strength and rigidity.
- **Safer** . . . with interlocked front safety door and large rear guard.
- **Simple to maintain** . . . manifold type valve mountings and complete accessibility of all parts reduces maintenance problems.

In the new REED *Autoflow* extruder, you get five distinct advantages over conventional machines. The *Autoflow* gives you greater output in pounds per horsepower per hour, plus outstanding ability to color and compound. Its precise speed and temperature control, combined with balanced working pressures and fast through-put at the plasticizing area, mean a more even flow of higher quality product, especially when you are working with heat-sensitive materials.

At Reed-Prentice headquarters, there is a 51-man Engineering staff devoted to further development, application and testing of equipment. This backs up the coast-to-coast REED sales and service organization, helps assure you of getting better equipment specifically designed to your present *and* future needs.

FULL REED INJECTION LINE

SPECIFICATIONS
Mold clamping pressure, tons
Mold clamping stroke
Platen size (WxH)
Diameter of tie bars
Space between bars
Rated casting area, square inches
Plasticizing capacity, pounds per hour
Dry cycle time, seconds

REED-PRENTICE

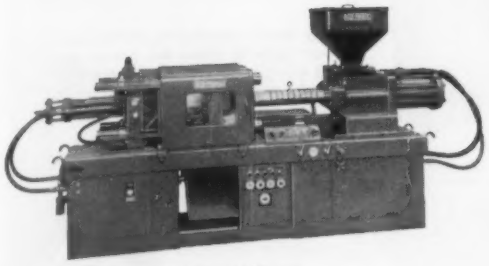
Affiliate of PACKAGE MACHINERY COMPANY

WORCESTER 4, MASS.

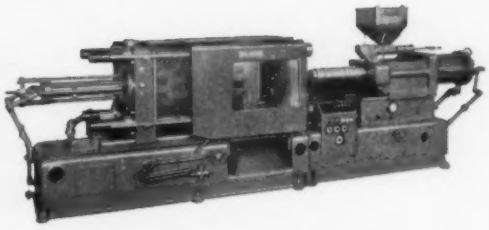
BRANCH OFFICES: NEW YORK • CLEVELAND • CHICAGO • BUFFALO • DAYTON • DEARBORN • KANSAS CITY • LOS ANGELES

REPRESENTED IN CANADA BY: BARKER INDUSTRIAL EQUIPMENT, LIMITED, TORONTO

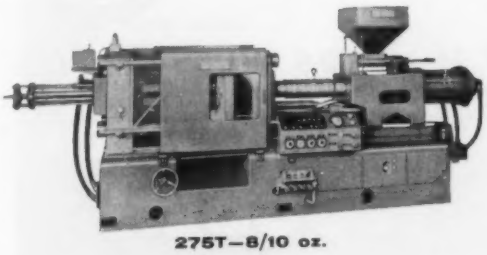
REED LINE



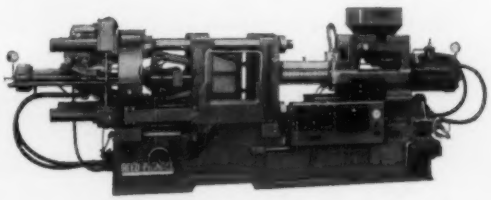
175T—4/6 oz.



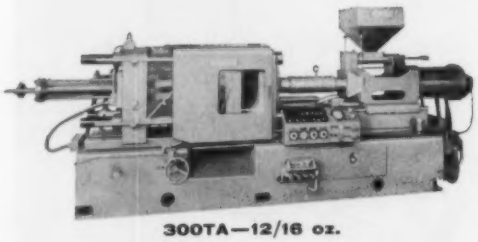
400T—16/20 oz.



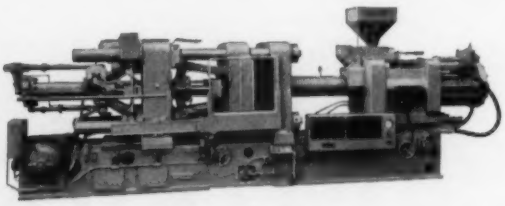
275T—8/10 oz.



450T—20/24 oz.



300TA—12/16 oz.



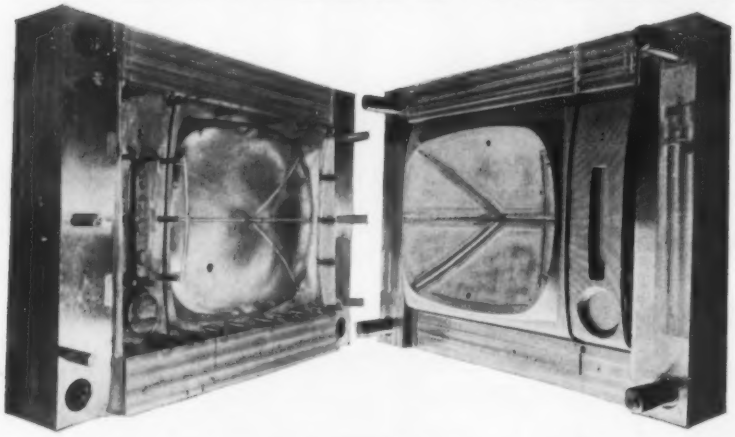
600T—32 oz.

175T 4/6 oz.	275T 8/10 oz.	300TA 12/16 oz.	400T 16/20 oz.	450T 20/24 oz.	600T 32 oz.
175	275	300	400	450	600
5-8"	6¼-10¼"	7½-12½"	8-14"	16"	24"
22 x 24½"	22½ x 25"	29 x 32½"	38 x 36"	45 x 40"	54 x 45"
3"	3½"	4"	4½"	5"	6"
13½ x 13½"	11¼ x 14¼"	15 x 20½"	23½ x 23½"	22½ x 25½"	26½ x 30½"
75	125	150	175	200	300
75	120	125	130	135	150
6	8	10	14	18.6	21



REED AUTOFLOW 100-H EXTRUDER

FLAWLESS MOLDS for . . .



INJECTION
COMPRESSION
TRANSFER
FIBERGLAS AND
PREMIX MOLDING

This sharply detailed television mask mold was expertly made by Anson—using a 16 x 30 Cincinnati Hydrotel, working from blocks measuring 5 x 29 x 40 inches.

- Anson precision-engineered molds give ultra-smooth surface finishes to your molded parts.
- Anson's industry-famous polishing department can be relied upon for mirror-like optical finishes.
- Anson design engineers have all served formal apprenticeships in the tool and die industry.
- Anson maintains a wide range of specialized equipment for all types of molding problems.
- Anson has a long established reputation for prompt delivery.

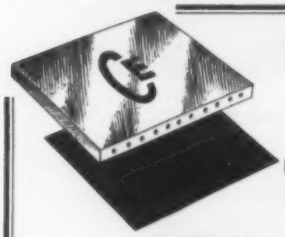
That's why so many automobile, refrigerator, radio, television, and small appliance manufacturers, from all over the country, specify Anson molds for their products.

Write today for further information to

ANSON TOOLS & GAGES, INC.

1504 W. 12th St., Erie, Pa.

ANSON MOLDS FOR PLASTICS



STEAM ELECTRIC
OIL
•
HEATING COOLING
or HEATING and COOLING

PLATENS
HOT PLATES

•

Quality . . . AT A PRICE

Deliveries . . . TO SATISFY YOUR MOST URGENT NEEDS

•

We offer a complete THERMO ENGINEERING SERVICE
O. E. M. Arrangements Available
SIMPLE DIE SETS

•

CUSTOM ENGINEERING CO.

P. O. Box 1343 • Phone 0-1335 • Erie, Pa.

WOODEN
SHELLS • ROLLS • CORES

for the

TEXTILE • RUBBER • PAPER • PLASTIC and other industries



OPTIONAL TYPES

• The CAP WELD SHELL shown above is designed for heavy duty rolling and offers the maximum in long-life service.

- CAP WELD SHELLS
- MACHINE ROLLS
- LAG ROLLS
- CAPPED END SHELLS
- CAPPED SQUARE SHELLS

These cylinders are all available in standard diameters or can be supplied on order to meet your individual specifications.

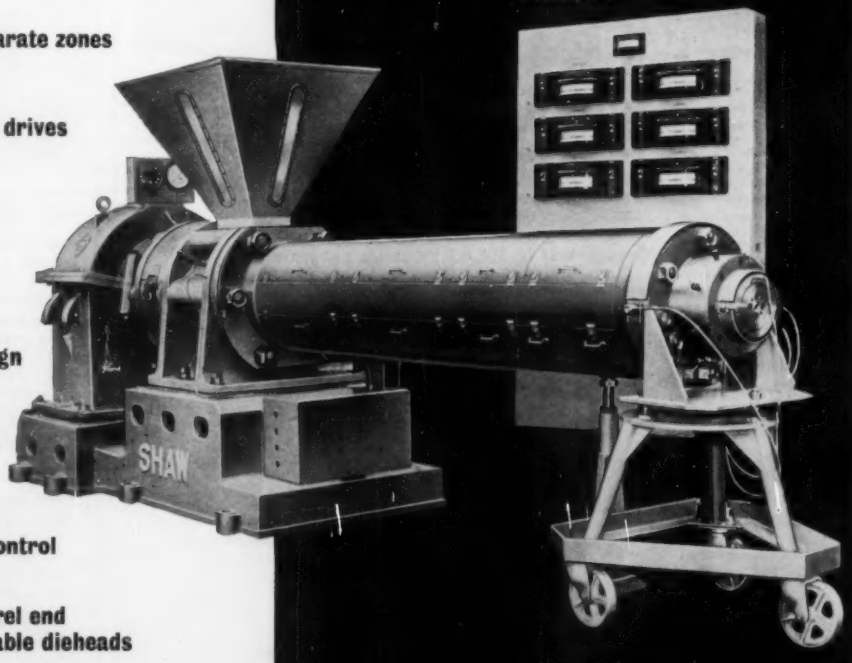
CYLINDER MFG. CO.
HAWTHORNE, N. J.
ESTABLISHED 1916

Send for descriptive Brochure

eight pointers to productivity

Combined to ensure high speed operation and top quality extrusion of piping, sheeting, miscellaneous sections and insulation or sheathing of cables, these outstanding features are found on all large models of the Shaw Plastic Extruder range. When you install Shaw equipment, you install dependability. Shaw's experience in the manufacture of plastic machinery is as old as the Industry itself. That's why you can rely on Shaw equipment to do the job perfectly.

- water cooled screw and feed box
- all-electric heating in separate zones
- variable speed drives
- screw speed indication
- special long screw of high efficiency design
- full temperature indication
- proportioning temperature control
- supported barrel end and transportable dieheads



SHAW

quality engineering for quantity production

plastic extruders

LARGE

FRANCIS SHAW (CANADA) LTD GRAHAMS LANE BURLINGTON ONTARIO CANADA

TELEPHONE NELSON 4-2350 TELEGRAMS CALENDERS BURLINGTON ONTARIO

FRANCIS SHAW & CO LTD MANCHESTER 11 ENGLAND TELEX 66-357

P4776

DESTACO

TOGGLE CLAMPS Boost PRODUCTION



Any time you need a work-holder for plastic parts for shaping, cementing or any other phase of processing, you will find a DE-STA-CO Toggle Clamp to fit the need! Further, DE-STA-CO's bring you extreme flexibility in fixture design!

Also, many Clamps are available in aluminum (for lightness) as well as steel. Air-operated Clamps are among the many new and original models which are also now available.

For complete 40-page DE-STA-CO catalog, full information on any Clamp or for assistance on any tooling problem . . .

CALL ON YOUR NEAREST DE-STA-CO STOCKING DISTRIBUTOR!

ALABAMA
Dixie Type & Supply Co.
930 N. 6th Avenue
Birmingham 4

ARIZONA
Norman S. Wright & Co.
2641 E. Adams Street
Phoenix

CALIFORNIA
Norman S. Wright & Co.
1361 Abby Streeet
Fresno 3

Norman S. Wright & Co.
625 N. Alvarado Street
Los Angeles 26

Norman S. Wright & Co.
1015 Folsom Street
San Francisco 3

Norman S. Wright & Co.
1102 T. Street
Sacramento 14

COLORADO
Aviation Service Supply Co.
3900 Ulster
Denver 7

GEORGIA
Pye-Barker Supply Co.
231 Pryor Street, S.W.
Atlanta 3

ILLINOIS
George A. Rieke Co.
Pedersen Bros. Tool & Supply Co.
623 W. Washington Blvd.
Chicago 6

INDIANA
General Supply & Tool Co.
140 S. Senate Avenue
Indianapolis 4

IOWA
Globe Machinery & Supply Co.
401 E. Second St.
Davenport

KANSAS
H-H Tool & Supply Co.
317 So. St. Francis
Wichita 2

KENTUCKY
De-Qu-Ko, Inc.
212 Eiler Avenue
Louisville 14

MASSACHUSETTS
F. H. Robertson Co., Inc.
420 Broadway Avenue
Malden 48

MINNESOTA
Northern Machinery & Supply Co.
2001 Washington Ave. S.
Minneapolis 1

MISSOURI
Ernst Machinery Co.
1606 Oak Street
Kansas City 4

H. O. Monahan
1007 Yale Avenue
St. Louis 17

NEW YORK
Root-Neal Co.
64 Peabody Street
Buffalo 2

Acme-Danneman Co., Inc.
45 West 18th Street
New York 11

Tool & Die Supply
17 Silver Street
Rochester 11

M. J. Kelly Supply Co.
323 E. Water Street
Syracuse 1

OHIO
Die Supply Company
1400 Brookpark Road
Cleveland 9

Die Supply Sales Co.
311 Vermont Street
Dayton 4

F. N. Cuthbert, Inc.
2909 Detroit Avenue
Toledo 10

OREGON
Norman S. Wright & Co.
3607 S.W. Corbett St.
Portland 1

PENNSYLVANIA
Paul J. Fleming & Son
907 W. Wagner
Philadelphia 41

TENNESSEE
Mr. Ralph Landrum
1211 4th Avenue
Nashville 10

Lewis Supply Co.
477 S. Main Street
Memphis 2

TEXAS
Tool Supply & Engr. Co.
1901 Canton Street
Dallas 1

Dolan Industrial Sales
5506 Lawndale Avenue
Houston 23

WASHINGTON
Norman S. Wright & Co.
235 Ninth Avenue, North
Seattle 9

Norman S. Wright & Co.
125 S. Stevens
Spokane 4

WISCONSIN
Triplex Supply Co.
830 N. Third Street
Milwaukee 3

ONTARIO
Williams & Wilson Ltd.
11 Front Street, East
Toronto 1

Williams & Wilson Ltd.
1465 Tecumseh Blvd., E.
Windsor 3

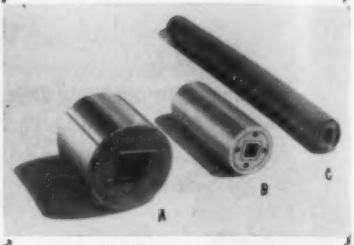
QUEBEC
Williams & Wilson Ltd.
544 Inspector Street
Montreal 3

DESTACO **DETROIT STAMPING COMPANY**
327 MIDLAND AVE. • DETROIT 3, MICH.



JOANNA STOCK SHELLS and SHIPPING CORES

can cut your inplant stock winding and shipping costs!



3 different types

A—Aluminum MILL ROLL and WINDING CORES . . . for lightweight inplant stock winding

Easy-to-handle cores, yet exceptionally sturdy for rugged material winding applications. Cores have square hole insert of *steel* tubing—which will not wear. For any type shaft. Diameters up to 10" O.D., any desired lengths.

B—All-Steel MILL ROLL and WINDING CORES . . . for heavy duty inplant stock winding

Rugged, life-time cores, made of durable steel tubing. Ends will never wear! Furnished with any size tubular steel insert for fast, easy locating and winding on any type shaft. All sizes up to 6" O.D.

C—Metal End PAPER CORES . . . for low-cost, safe shipping of all types of plastic materials

Lightweight, low-cost, *returnable* cores with welded, reinforced ends —of 16 and 20 gauge steel. Ends have 1¼" opening for square bar. Standard dia.—3½" O.D. with ¼" wall, any desired length.

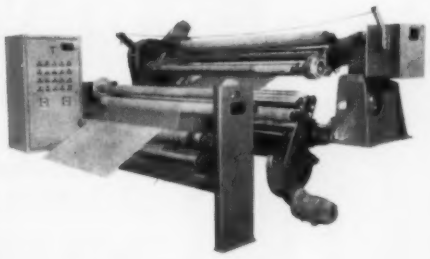
JOANNA STOCK SHELLS (A, B) save time and protect materials in all inplant stock winding applications. JOANNA SHIPPING CORES (C) prevent damage in transit — plastic sheeting, etc., stays in factory-fresh condition.

Let experienced CORE SPECIALISTS save you time and money—whatever your inplant or shipping problems. You always get prompt service — even for special custom-made cores. WRITE OR CALL FOR INFORMATION AND QUOTATIONS TODAY!

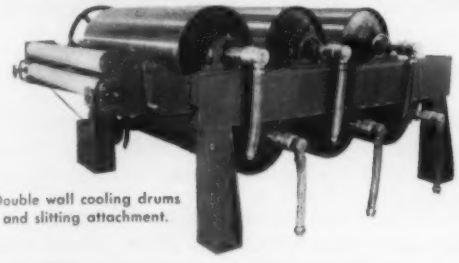
Phone CAnal 6-6166

PRODUCTION METAL PRODUCTS CO., INC.
421 N. SANGAMON STREET, CHICAGO 22, ILL.

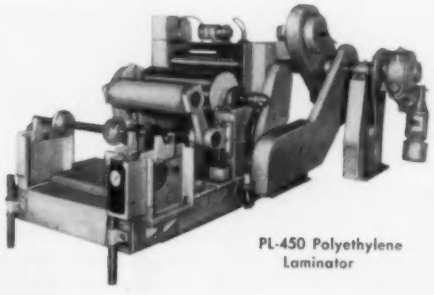
Dilts ENGINEERS AND BUILDS COMPLETE TAKE-OFF EQUIPMENT FOR PLASTIC CALENDERS • COOLING TRAINS AND PLASTIC WINDERS • POLYETHYLENE EXTRUSION-LAMINATORS . . . . . .



Model 40 Continuous center winder with automatic start for high speed controlled plastic winder.



Double wall cooling drums and slitting attachment.



PL-450 Polyethylene Laminator

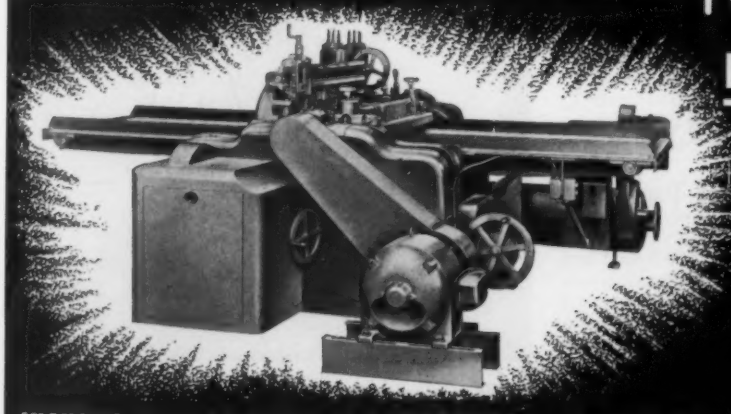
THE BLACK-CLAWSON COMPANY

DILTS DIVISION • FULTON, N. Y. • LYRIC—2-4265

BUSS MICRO-SURFACER *a Revolutionary*

PATENTED

LARGE-VOLUME SIZER



OF RUBBER and VINYL FLOORING

★

RUBBER COMPOSITION and KINDRED PRODUCTS

★

EXTRUDED, MOLDED and LAMINATED PLASTIC SHEETING

★

VERY THIN FLEXIBLE and HIGHLY ABRASIVE MATERIALS

★

This machine, if applicable to your production, can save you many thousands of dollars through faster, better processing. Let us consult with you concerning any possible application.

INSURES UNIFORMITY with PRECISION ACCURACY... .001" TOLERANCE, VASTLY INCREASED PRODUCTION

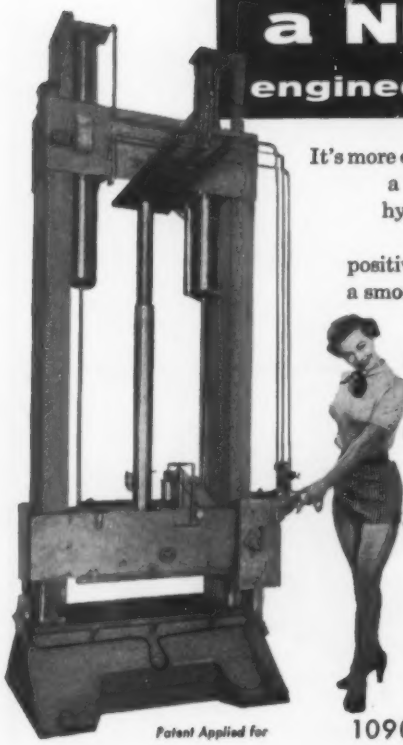
Eliminates dirt and grit. Handles thick or thin materials up to 50 inches wide with sufficient H.P. for sizeable cuts. Provided with variable feed suitable for a wide range of materials. Built-in knife grinder and other features for minimal maintenance.

BUSS MACHINE WORKS *Planer Specialists Since 1862*

300 EIGHTH STREET, HOLLAND, MICHIGAN

a NEW press design

engineered specifically for the industry



It's more economical to own and operate a D-K Hi-Speed Molding Press. By utilizing a combination of air and hydraulic pressure with simplified, self-contained hydraulic system, expensive separate pumping units are eliminated. The result is a press with a larger, more accessible working area, positive control with fine adjustments on both fast and slow closing speeds and a smooth flow of power. Extremely fast closing speeds are achieved, facilitating use of more highly catalyzed resins and a faster curing cycle.

LOW INITIAL COST . . . through simplified design, skillful engineering and the elimination of complicated mechanical devices.

LOW OPERATING AND MAINTENANCE COSTS . . . Power requirements are less by utilizing a combination of air and hydraulic pressure with a minimum of moving parts.

VERSATILITY . . . Stroke, daylight openings and pressure can be furnished in a wide variety of combinations; platen, heated or cold, can be furnished to customer's specifications.

Write today for illustrated brochure giving complete details

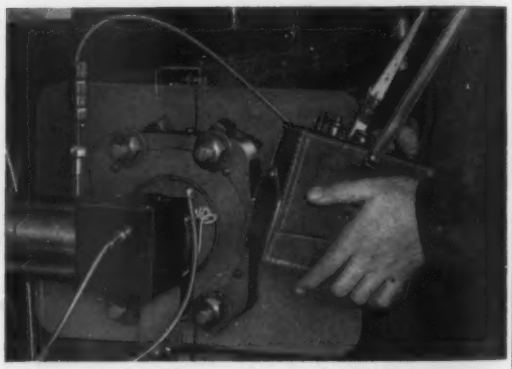
DAVIDSON-KENNEDY CO.

1090 Jefferson St. N.W. Atlanta, Georgia

Patent Applied for

Check Actual Stock Temperatures Quickly Accurately

With T-E's Three-Unit Package



COURTESY—NATIONAL RUBBER MACHINERY CO.

Checking stock temperature with T-E's three-unit package



"MiniMite" Pyrometer Indicator

For fast, convenient and highly accurate quality control of plastic extrusions—T-E's three-unit, temperature measuring package is ideal. With it you can check actual stock temperatures—and then correlate these to controllers for correct settings. It helps you avoid production losses during start-up or when ambient conditions vary. The package includes T-E's (1) "Plastic Melt" thermocouple, (2) "MiniMite" Portable Pyrometer Indicator and (3) extension wire with jack connector. With the "Plastic Melt" thermocouple installed in the extruder, the "MiniMite" can be connected in seconds to provide a rapid reading. Accurate to ¼ of 1% of scale range, the four lb. "MiniMite" can also be used to check other thermocouples or to calibrate controlling instruments.

Write for Bulletin 3-P.

Thermo Electric Co. Inc.

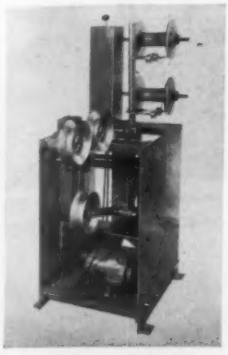
SADDLE BROOK, NEW JERSEY

In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

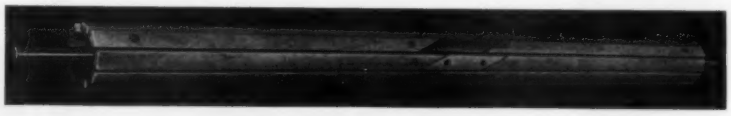


T-E's "Plastic Melt" Thermocouple

AUXILIARY MACHINES FOR HANDLING EXTRUSIONS

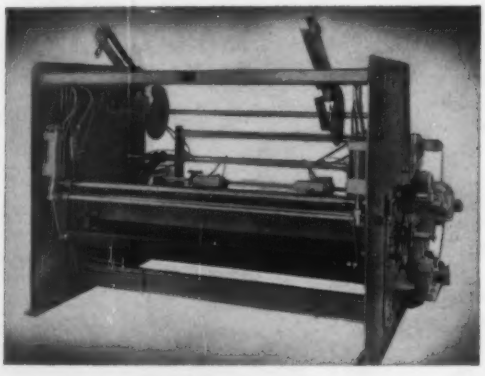


While what occurs inside the extruder has a great effect on the finished extrusion, you cannot overestimate the importance of the handling it receives once it leaves the die. Cooling, tension, take-up and spooling all have a decided effect on the success or failure of your operation. Progressive machines for these operations have been widely acclaimed for their reliability, for their ease of adjustment, and for their ability to reduce scrap losses.



▲ SPOOLING MACHINE

This unit neatly winds extruded strips such as shoe welting, lacing, tubing, and strip gaskets onto spools. The standard model handles a 12" diameter spool, 12" wide. Adjustable traverse for different width extrusions insures even winding. Diameter build-up is compensated for by dancer rolls which maintain constant linear winding speed and uniform tension. The drive has a speed range from 20 to 1.



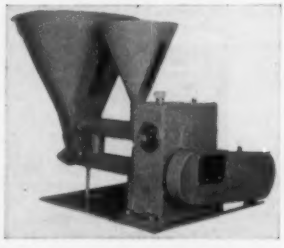
▲ AUTOMATIC BATCHER

Just load the magazine of the Progressive Automatic Batcher with cardboard tubes and set the desired number of yards per tube on the ocntrols. Then, without requiring additional attention, other than the replenishment of the tube supply, the Automatic Batcher will wind the proper yardage, cut off the film and start winding on a new tube!

▲ ANTI-WRINKLE SLAT EXPANDER

Smoothes out plastic film and fabrics during continuous roll operations. Expander slats move outward from center, pressing out any creases or wrinkles in the web. Permits operation of processing machinery at higher speeds. Delivers tight, neat rolls, improves printing register, cuts reject losses.

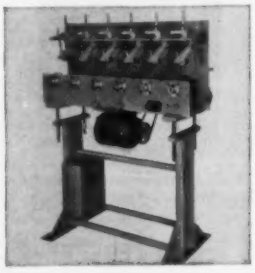
FASTER COLOR MIXING AT THE EXTRUDER ▼



Progressive has developed a new mixing method for extruders who want fast color changeovers with minimum waste material and minimum downtime. This method eliminates the necessity for stopping the extruder for cleaning, or for making any alterations in the extruder set-up.

The Progressive color mixer fits the hopper of any extruder. It feeds and mixes neutral dry-blend powder and carefully measured portions of color chips. The delivery of the unit is matched to the extrusion rate. *Full details on this cost-reducing device are available on request.*

RIGID PIPE PULL-OFF ▶



This machine pulls pipe from the diet at a uniform rate. Six paired rubber covered pull rolls and adjustable spring-loaded hold down rolls distribute tension over a length of pipe. The hold down rolls have quick toggle release for starting the pipe. The standard unit accommodates up to 8" O. D.; the roll assembly is adjustable for various other diameters. A 20 to 1 speed range electronic drive powers the machine.

Progressive machine co., inc.

Specialists in Plastic Film Handling Equipment

198-202 East 25th Street — Paterson 4, N. J.

New England Sales Rep: Barrett & Breen Co., 80 Federal St., Boston 10, Mass.

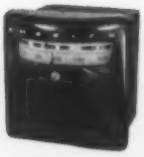
Progressive also manufactures film takeups, cut-off reels and slitters, film rewinders, and other machines for plastics extrusion and film handling.

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

In plastics . . . it's WHEELCO for the "extras" that really count



400 Series Capacitrols are available in six control forms



Full plug-in Wheelco design is demonstrated by removal of measuring system



Model 297 offers finest low-cost temperature control



Typical control center provides multi-zone heat control for molding machine

Here are three outstanding "extras" available to every user of Wheelco instruments throughout the plastics industry.

1. Advanced design features — plug-in components, flexibility of operation, use of standard components for easy maintenance, etc. — all combined in the most complete line of top-quality instruments available.

2. A nationwide, factory-trained sales and service engineering organization, working closely with machinery builders and users.

3. Training programs for instrument technicians and supervisors conducted regionally by broadly experienced Wheelco instrument engineers.

Throughout the plastics industry, instrument men and production executives agree that it pays to see Wheelco first whether you need a single instrument or a complete control center. Get more details by writing today for your copy of Bulletin F-6485, "Capacitrols for the Plastics Industry."

BARBER-COLMAN COMPANY

Dept. U, 1589 Rock Street, Rockford, Illinois, U. S. A.

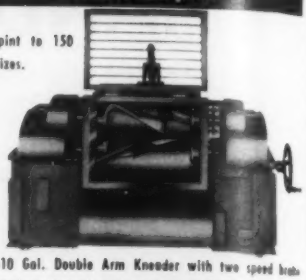
BARBER-COLMAN of CANADA, Ltd., Dept. U, Toronto and Montreal, Canada

Industrial Instruments • Automatic Controls • Air Distribution Products
Aircraft Controls • Small Motors • Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

Ross

Leading mfrs. of MIXING AND GRINDING EQUIPMENT for over 90 years

• 1 pint to 150 gal. sizes.



#41L–10 Gal. Double Arm Kneader with two speed brake motor. Jacketed trough and motor operated lift optional.



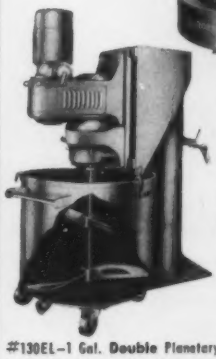
• 4½ x 10, 6 x 14, 9 x 24, 12 x 30, 14 x 32, 16 x 40" sizes.

#52TC–14" x 32" High Speed Three Roller Mill. Hydraulic adjustment and pressure recording gauges optional.

#30C–50 Gal. Heavy Duty Change Can Mixer. Adjustable outer scraper, cover with charging port, and gates on cans optional.



• 8, 16, 20, 50 and 60 gal. sizes.



#130H–250 Gal. Change Tank Mixer with hydraulic raising and lowering and variable speed motor. Various type stirrers and high speed impellers optional.

• 80, 150 and 250 gal. sizes.

#130EL–1 Gal. Double Planetary type Change Can Mixer with shearing action stirrers, and variable speed reversing type motor. Jacketed cans and portable trucks for cans optional.



• 1, 2, 3, 4, 6, 15, 25, 50, 65, 85, 110 and 150 gal. sizes.

Write for complete information on these or other types of Ross equipment.

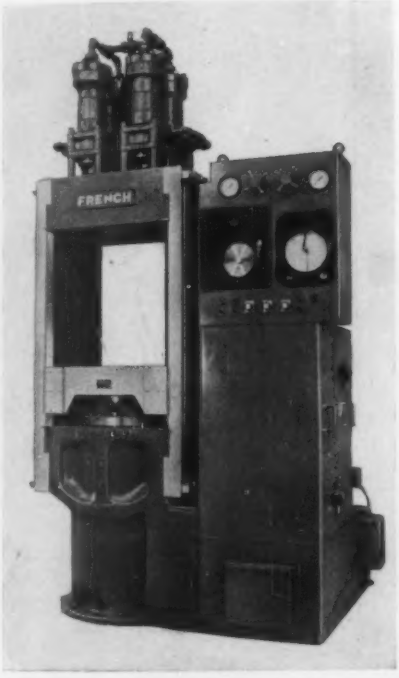
CHARLES ROSS & SON COMPANY, INC.

150-152 CLASSON AVENUE, BROOKLYN 5, NEW YORK

FRENCH HYDRAULIC PRESSES

for Compression Molding, Transfer Molding, Laminating

Many optional features offered on our standard line of presses.



615 Ton Compression & Transfer Molding Press
25″ Diameter Ram
2500 P.S.I. Working Pressure
24″ Stroke
36″ Daylight
32″ x 32″ Pressing Surface

All sizes, up to 5000 tons, oil or water, self-contained or for use with accumulators.

Patented features of the side plate construction press illustrated offer several advantages over column construction. The accompanying table shows standard sizes available in both column and side plate presses.

STANDARD SIZES • HOT PLATE PRESSES
FRENCH OIL MILL MACHINERY CO.
TABLE OF PRESSURES PER SQUARE INCH OF PLATEN AREA

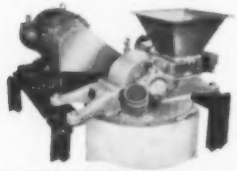
RAM DIAMETER	TONS @ 2000 PSI	STANDARD PLATEN SIZES								
		20 x 20	24 x 24	30 x 30	32 x 32	36 x 36	40 x 40	42 x 42	48 x 48	50 x 50
		POUNDS PER SQUARE INCH OF PLATEN AREA								
10	79	393								
12	113	565	393							
14	154	770	535							
16	201	1005	698	447						
18	254		884	566	497					
20	314		1091	698	614	485				
22	380			845	743	587	475			
24	452			1005	884	698	566	513		
26	531				1037	819	664	602	461	
28	616					950	770	698	535	493
30	707					1091	884	801	614	566
32	804						1005	912	698	643
34	908						1135	1029	788	726
36	1018							1154	884	814
38	1134								985	907
40	1257								1091	1005
42	1385								1203	1108

Write for illustrated bulletin.

THE FRENCH OIL MILL MACHINERY CO.
(HYDRAULIC PRESS DIVISION)
1066 GREENE ST. PIQUA, OHIO

ULTRA-FINE TO GRANULAR MATERIALS

for the Plastics Industry



The MIKRO-PULVERIZER—
for granular or fine grinding



The MIKRO-ATOMIZER—
for ultra-fine grinding

These MIKRO-D units are engineered to improve molding compounds and synthetic resins by perfect blending, fine grinding or controlled granulation to uniform particle size. In addition, they assure excellent results in grinding scraps and flashings.

THE MIKRO-PULVERIZER—a dustless pulverizer for dry or liquid milling, granulating, fine grinding and blending . . . no fans, cyclones or separators. Recent developments make it even more efficient in handling of heat-sensitive materials. Bulletin 51A.

The MIKRO-ATOMIZER—a 3-functional mill that pulverizes, air-classifies and conveys material in one operation. Cool, highly compact, it eliminates air conveyor, bucket elevator and screw conveyor. It is a mechanical, screenless pulverizer for production of smooth, ultra-fine powders in the 1-25 micron range. Bulletin 51G.

Also—the new jet-action MIKRO-PULSAIRE Collector—for optimum dust recovery—lowest maintenance costs. And, the MIKRO-Collector, standard of the reverse jet-ring type dust collectors.

Mikro-D

PULVERIZING MACHINERY DIVISION
Metals Disintegrating Company, Inc.
30 Chatham Rd. Summit, N. J.

PULVERIZING • AIR CONVEYING • DUST COLLECTING EQUIPMENT

Do you know all the latest ways to cut your packaging costs?

Are you familiar with new developments in package design that stimulate retail sales?

Are you sure you're using the best kind of package to protect your product from damage?

If you had to answer "No" to any one of these questions, it's likely that you're unnecessarily losing money every business day.

Fortunately there's an easy way out: MODERN PACKAGING magazine! It's the world's most authoritative publication devoted exclusively to packaging problems and their solutions. It analyzes all of the newest developments in packaging—materials, machinery, design and production. It reports each of the latest ways to merchandise packaged products of all types, from frozen foods to monkey wrenches.

The cost of an annual thirteen-issue subscription—including the giant annual Encyclopedia Issue—is only $7.00 in the U.S., its possessions and Canada; $20 elsewhere. You can begin yours today simply by writing us on your business letterhead. We'll bill you later.

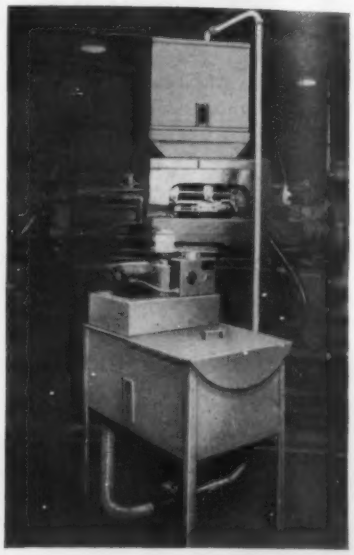
MODERN PACKAGING
MAGAZINE
575 MADISON AVENUE,
NEW YORK 22, N. Y.

Dries as it loads

D&W Hopper Dryer

and NEW combination

automatic Jet HOPPER LOADER



for all EXTRUSION and INJECTION machines...

- Dries and preheats material at less cost than with conventional drying ovens.
- More production because of properly controlled material conditioning—fewer rejects.
- Compact size saves space. Installed in minutes on any standard extrusion or injection machine.
- Dries and preheats as it loads. Requires no compressed air. Thousands proved in use.

Available for any size installation, large or small.
Write today for full information.



Typical installations



THORESON-McCOSH, Inc.

18208 W. McNichols – Detroit 19, Michigan – KEnwood 1-8477



For Flawless Blown Film

complete installations for lay-flat tubing up to 55" double width

For extra heavy Requirements

our 6 inch extruder, model S-150 in 25:1 Le/D ratio incl. temperature control cabinet and recorder





For Heavy Sheet Material

fully automatic installations incl. polishing-, take-off-, and shooter

For Uniform Flat Film

complete installations for flat film up to 60" width, incl. combined take-off-trimming- and wind-up equipment





For Calibrated Pipes

complete installations for pipes: our 3½" extruder, model S 90 RGV in 20:1 Le/D ratio, incl. control cabinet, patented calibrating device, pipe haul-off and cutting device

Packaged Reifenhäuser-Installations

are fully automatic in operation and assure fast continuous production

Representative for sales and service in USA:

H. H. HEINRICH, INC.

111 Eighth Avenue, NEW YORK 11, N.Y.

A·Reifenhäuser

MASCHINENFABRIK

TROISDORF • WEST GERMANY

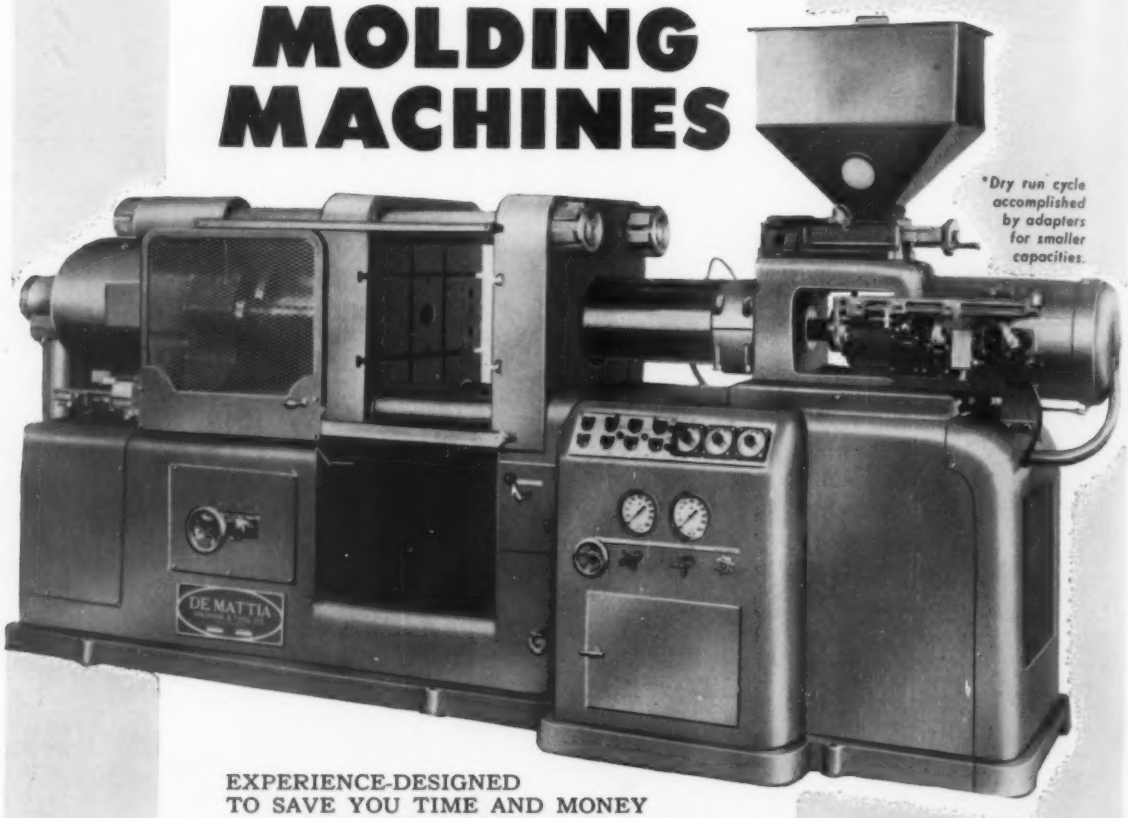
NOW—improve your molding production!

—WITH THE SENSATIONAL NEW

DE MATTIA
SERIES M
MOLDING MACHINES

- IMPROVED DESIGN
- FULLY HYDRAULIC OPERATION
- UP TO 6 CYCLES PER MINUTE*
- 16 OUNCES BY AUTOMATIC PRE-PACKING

*Dry run cycle accomplished by adapters for smaller capacities.



EXPERIENCE-DESIGNED TO SAVE YOU TIME AND MONEY

the new Model M Molding Machines are another step forward in molding production. These high efficiency injection machines help you meet competition... are expressly designed to increase your molding production and cut your molding costs. Series M machines offer fully hydraulic operation, up to 6 cycles per minute on smaller shots and shots up to 16 ounces by means of automatic pre-packing!

Available in 8 and 12 oz. Models. The De Mattia Line also includes 4 oz. Verticals, 4 oz. Horizontals and Various Models of Scrap Grinders. Write for Illustrated Bulletins.

DE MATTIA MACHINE and TOOL CO.

DE MATTIA MACHINE and TOOL CO.

CLIFTON, N. J. • N. Y. Sales Office: 50 Church St. • Cable Address: Bromach, N. Y.

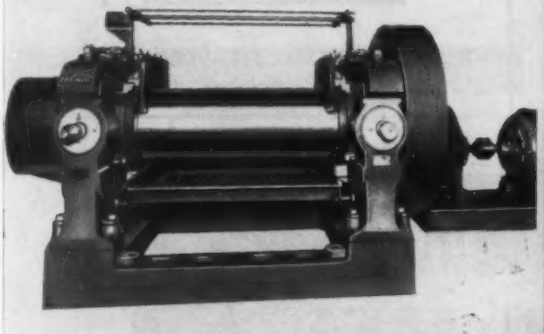
Consult ERIE ENGINE & MFG. CO.

for prices and delivery

MILLS • •

for the RUBBER and PLASTICS INDUSTRIES

EEMCO mills for mixing and compounding rubber and plastics are available in all sizes from laboratory mills up to and including 84" mills in standard or custom units.

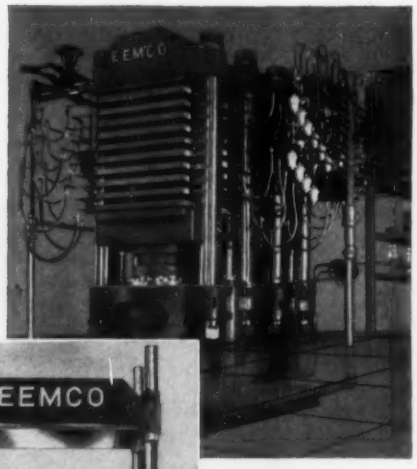


HYDRAULIC • • PRESSES

for RUBBER and PLASTICS PROCESSING

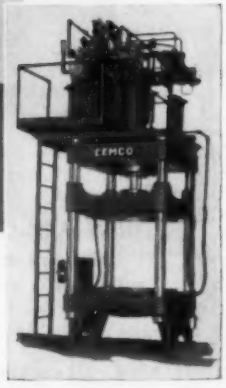
REINFORCED PLASTICS MOLDING

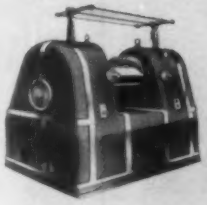
EEMCO heavy duty hydraulic presses are also available in a complete range of sizes from the 12" x 12" 42 ton laboratory press up to any size required. EEMCO designs and builds special presses to meet the customer's requirements.



EEMCO furnishes complete installations for reinforced plastics molding—presses, hydraulic units, preform machines, roving cutters and ovens.







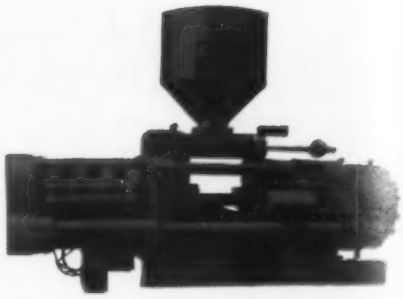
Call or write us for complete details. We will be glad to discuss your "Mill and Press problems"—of course, at no obligation to yourself.

EEMCO **ERIE ENGINE & MFG. CO.**

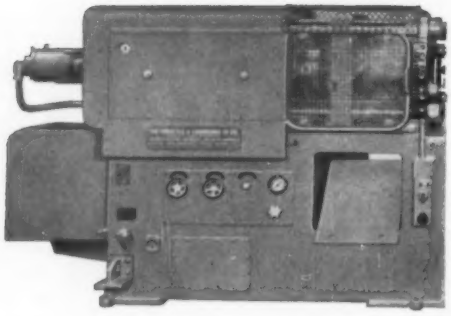
951 EAST 12th STREET, ERIE, PA.

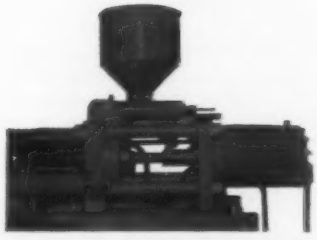
MILLS • PRESSES • LOADERS • LIFT TABLES • PLATENS • PREFORM MACHINES • ROVING CUTTERS

Peco



THE PECO IN-LINE PREPLASTICISER





THE PECO THERMAX PLASTICISING CHAMBER

½ oz. to 160 ozs.

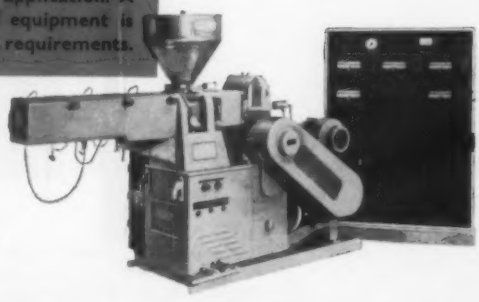
injection machines

This fine up to date range of machines includes the **IN-LINE** Preplasticiser for close control of critical moulding factors; the increased plasticising capacity of the **THERMAX** chamber ensures faster injection speeds. Both types of machine are designed to operate with a standard locking Unit and will meet the demands of the most discriminating moulder.

for a better quality product at lower cost

extrusion machines

PECO Extruders are universally recognised for their robust design and versatile application. A comprehensive range of take off equipment is available to cover most production requirements.



THE BLACK-CLAWSON CO., INC.
DILTS MACHINE WORKS DIVISION
FULTON, NEW YORK. TELEPHONE: 2-4265

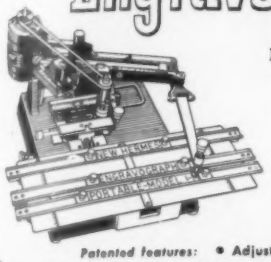
Illustrated literature and full specifications will be sent on request

injection moulding and extrusion machines

PECO MACHINERY SALES (Westminster) LTD., 28 Victoria Street, London, S.W.1. Tel: ABBey 1793
WORKS: THE PROJECTILE AND ENGINEERING CO., LTD., Thessaly Road, London, S.W.8

PECO PRODUCTS

Anyone in your plant can engrave
NAMES | NUMBERS
for equipment, parts, panels bins, etc.
with tracer-guided
Engravograph



Fast, on-the-spot marking with portable engraver, operated by unskilled labor. Engraves plastics or metals directly or on engraving stock.* Big savings on short runs, "one-shot" jobs, hurry-up jobs. 17,000 Engravographs in use.

Patented features: • Adjustable for 15 ratios • Automatic depth regulator • Self-centering holding vise • Adjustable copy holders

*For top versatility and durability, use GRAVOFLEX chip-proof flexible plastic, laminated in contrast colors. No filling. Easily sheared, bent, formed, punched. Costs less, lasts longer. Send for sample.

Send for booklet JE-1

new hermes ENGRAVING MACHINE CORP. 13-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

Additional copies of the famous, authoritative Plastics Properties Chart available to subscribers in limited quantities

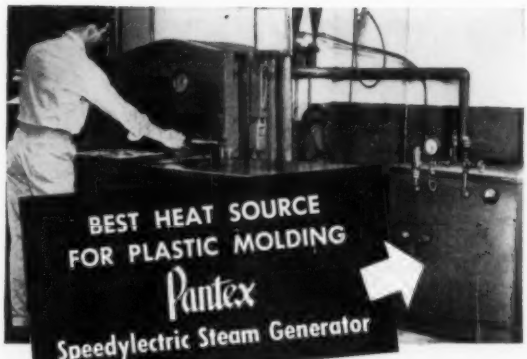
Order now . . . don't delay!

This clearly printed, wall-size chart contains essential data on the physical, chemical, thermal, electrical, and molding characteristics of all commercially available thermoplastics and thermosetting plastics. The identical chart is included with this copy of the Encyclopedia.

While the charts last, they are available at $1.00 each.

No COD's. Cash or check with order, please.

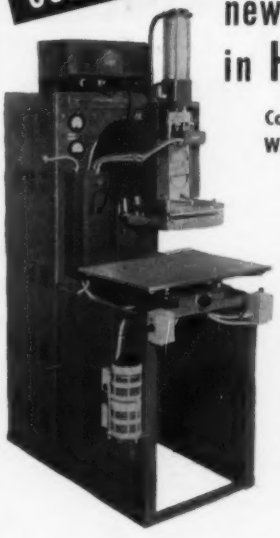
Industrial Magazine Service, Inc.
575 Madison Avenue New York 22, N. Y.



In this plant making plastic printing plates, each press *has its own Speedylectric steam boiler.* Each press is independent of the others, and each gets steam at the right temperature and pressure. There is no big boiler to waste power when only one or two presses are needed, and it takes only minutes to bring a press up to temperature for a rush order.

For every plastic molding operation, a Speedylectric steam generator is the ideal answer. Using the most economical method of generating steam electrically, its design eliminates low-water hazard and practically removes the need for attendance. Maintenance is nil, and there's no risk of fire or explosion. Sizes from 2 to 60 Bhp, 15 to 500 psi and higher. Requires 220, 440, or 550 v A.C. UL listed, ASME Code. For more information write Pantex Mfg. Corp., Box 660S, Pawtucket 8, R. I.

COLORFUL SEALING



newest advancement in HEAT SEALING

Cosmos electronic Heat Sealers With exclusive COSMO-CHROME USA PAT. NO. 2747646

• Performs any standard heat sealing operation. *In addition,* it seals different colored edges, and seals three dimensional appliques in several different colors in a single operation.
Has more working power than any other machine with the same rating.
That's why more than 90% of our customers who have been using heat sealing machines of other makes switched to Cosmos.

Ask for details and sealing samples.

Cosmos Electronic Machine Corp.
656 Broadway, New York 12, New York
Telephone GRamercy 7-7700
Distributors from coast to coast and all over the world. Write for name of distributor in your area!

DEVILBISS

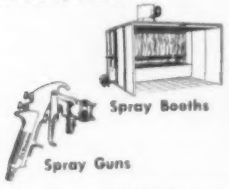
CATALYST SPRAY EQUIPMENT

(Eliminates pre-mix and pot-life problems)

When your spray requirements call for a simplified, efficient application of catalyzed foams or coatings:

polyester laminates • epoxies • iso-foams (urethane and polyethers) • converted varnish • wash primers (zinc chromates)

look to DeVilbiss for a complete line of spray equipment, technical experience, and research facilities. DeVilbiss engineers will be glad to analyze your application problems. Write the DeVilbiss Company, 290 Phillips Avenue, Toledo 1, Ohio.



Spray Booths

Spray Guns



Air Compressors



Hose and Connections

Air and Fluid Regulators

Paint Heaters and Material Tanks

Respirators and Hoods

Complete Finishing Systems



New DeVilbiss High-Volume Catalyst Spray Gun—Model P-JGC-504

FOR BETTER SERVICE, BUY DEVILBISS

THE DEVILBISS COMPANY, Toledo 1, Ohio

Barrie, Ontario • London, England

Branch Offices in Principal Cities

Solve
YOUR CUTTING PROBLEMS *with* Hobbs Shears and Cutters

Cut accurately, easily through paper, plastic, cloth, leather, etc., from rolls and sheets.



BENCH SHEAR — Cuts widths up to 10'. Twelve sizes available (without gauges) to fit any production set up. Special tables and gauges made to order.

UNIVERSAL SHEAR — Complete with table, has accurate gauges for cutting material into clean, uniform strips — 1/8" to 20" in width. Six sizes 30" to 60".

JACQUES JR. CUTTER (all metal) lighter, less expensive, has automatic material holder. Cuts 12" to 36" widths. Table and bench models.

POWER SHEARS to cut widths up to 60" at speed of 85 cuts per minute — automatic or semi-automatic. Details on request.

Write for literature

HOBBS MFG. CO.

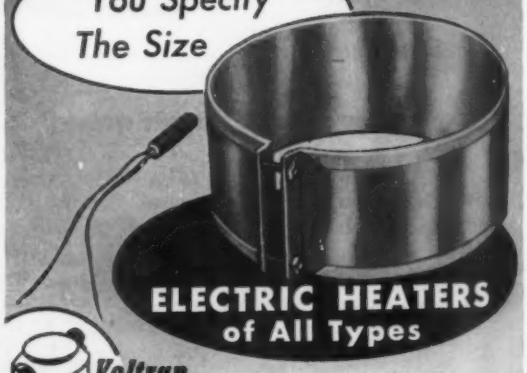
48A Salisbury St., Worcester 5, Mass.

Representatives in Irvington, N. J.; Chicago, Ill.; Cleveland, Ohio; Greenville, S. C.; Toronto, Ont.

WINDERS
HAND & POWER SHEARS
SLITTERS
DIE PRESSES
CORNER CUTTERS

HEAT
For Plastic Processing

You Specify The Size



ELECTRIC HEATERS of All Types



Voltrap
The Complete Contact Insulator

- For Machine Parts
- For Liquids
- For Air

ALSO SPECIAL REQUIREMENTS

INDUSTRIAL HEATER CO., INC.
417 CANAL ST., NEW YORK 13, N. Y.

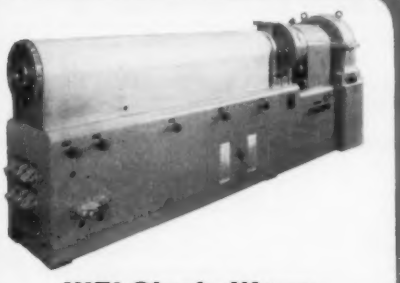
For Greater Processing Flexibility

Choose the WEI Compounder-Extractor-Extruder with the World's Greatest Leadership Experience

The guideposts for a successful future in the processing and manufacturing of plastics depends in a major part on the special abilities of the equipment your engineers choose. To be right up front with the ability to diagnose properly for handling—compounding, extruding—with or without extraction in both plastics and rubber, is the keystone of Welding Engineers' research and development in the service of the finest manufacturers in the world. For more than two decades, now, both management and production people, engineering and maintenance staffs have agreed that on ONE-OPERATION machinery . . .

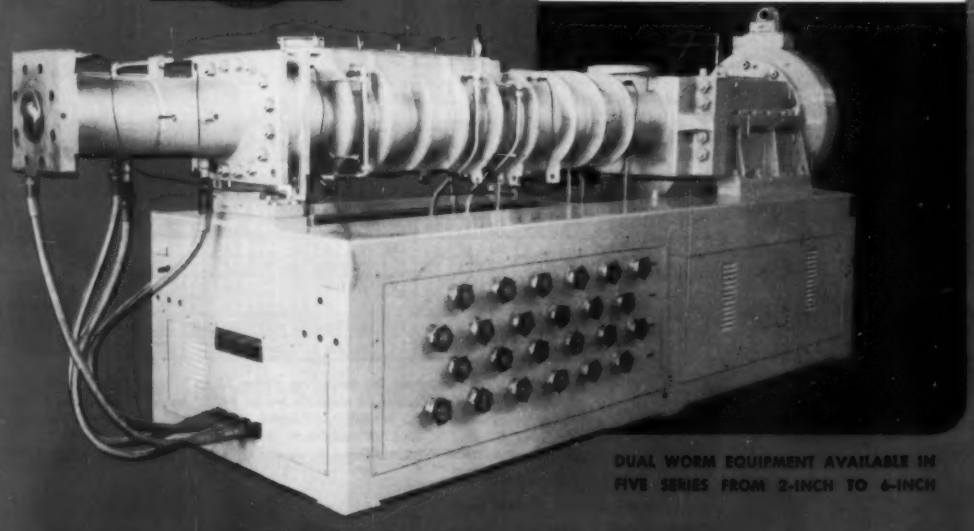
The Dual Worm Design Makes The Big Difference

Standard equipment "prescribed" on a custom-fitted basis from hundreds of combinations of flight characteristics, various barrel lengths, several working sections and ingenious extraction openings as required . . . to the most substantial production rates . . . with minimum floor space and all-in-one-operation labor economies.



WEI Single Worm Production Extruders

Designed and manufactured to super-strength, increased output standards under the same strict and experienced engineering quality control always associated with W.E.I. Dual Worm compounder-extruders. Ideal for continuous operation processing of most important thermoplastics. Write for catalog No. 642.



DUAL WORM EQUIPMENT AVAILABLE IN FIVE SERIES FROM 2-INCH TO 6-INCH

WELDING ENGINEERS, Inc. • Norristown, Pennsylvania

over 14,000 8,000 Different Cylinder SELECTIONS—

Miller

AIR AND HYDRAULIC

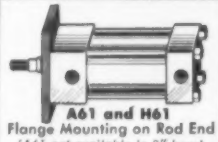
"STANDARDIZED" CYLINDERS

"IN STOCK" for immediate delivery

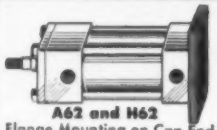
See Miller Bulletins A-105 (Air) and H-104 (Hydraulic) for Complete Dimensions and Engineering Data on these standardized "in stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 ft.

"IN-STOCK" MODELS

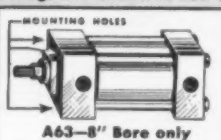
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.



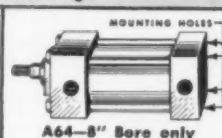
A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)



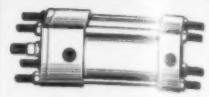
A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)



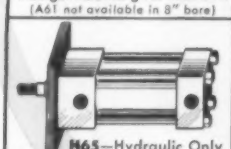
A63—8" Bore only
Flange Mounting on Rod End



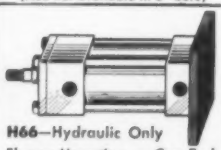
A64—8" Bore only
Flange Mounting on Cap End



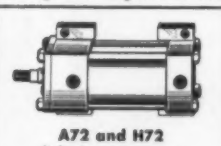
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



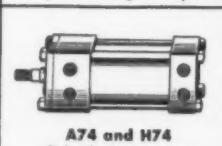
H65—Hydraulic Only
Flange Mounting on Rod End



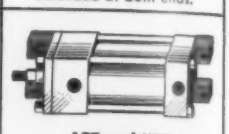
H66—Hydraulic Only
Flange Mounting on Cap End



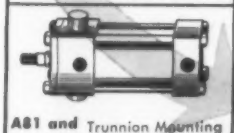
A72 and H72
Side Lug Mounting



A74 and H74
Side Flush Mounting

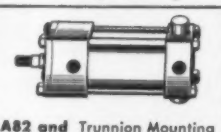


A77 and H77
Side or Foot Mounting

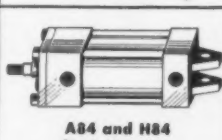


A81 and H81 Trunnion Mounting on Rod End

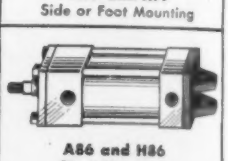
Your Choice of
CAP END CUSHIONED
ROD END CUSHIONED
or
BOTH ENDS CUSHIONED
on all cushioned strokes of all bores shown.



A82 and H82 Trunnion Mounting on Cap End



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES in Inches

"IN-STOCK" STROKES (in Inches)

	Bores	Rod Dia.	Rod Turn Down & Threads		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

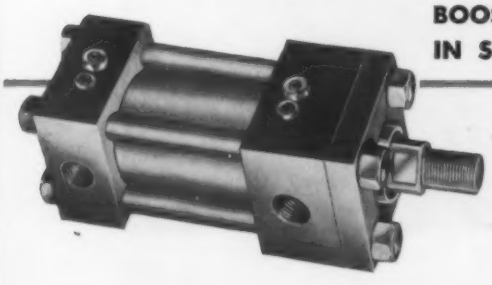
Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.



BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBAB, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.

Write For Catalog and Stock Price List

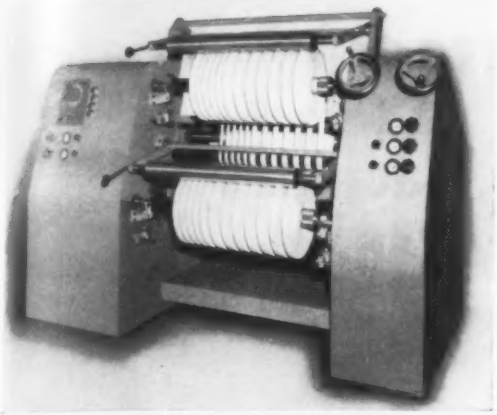
Miller

Miller FLUID POWER DIVISION
Flick-Reedy Corp

2020 N. Hawthorne Ave. • Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

TIME PROVED FOR VERSATILITY . . .



DUSENBERY

Slitter & Rewinder

MODEL 635

for FILM, FOIL, TAPE, PAPER

- **SHEAR CUT**
- **BURST CUT**
- **RAZOR BLADE**
- **SCORE CUT ***

In slitting plastic film, laminated foil, tape, glass cloth and paper, the model 635 utilizes the latest techniques and developments in the slitting and rewinding field.

The dual differential rewind, enables webs to be slit into four different widths of tape with individual tension controls for each width being rewound. The differential rewind principle produces high quality rewound rolls despite out of caliper mill rolls and materials, by allowing each rewound roll to slip with respect to its neighboring rolls and be wound up under its own controlled tension, thus reducing rejects and resulting in more economical production.

Change over from shear cut to razor blade or to burst, takes only a matter of minutes, giving complete versatility of slitting methods for handling a wide range of materials.

All tension controls on the unwind and rewind are air operated with gauges and regulators provided, to permit determination of optimum running conditions for a given material and to enable workers to repeat these settings without guess work. John Dusenbery Co., Inc., 274 Grove Ave., Verona, N. J., Tel: CEnter 9-3900.

**On special applications score cut can be provided.*

MANUFACTURERS OF:
SLITTERS, WINDERS,
CONSTANT TENSION UNWINDERS,
KNIVES, LEVERS, SLEEVES
SPECIAL CONVERTING EQUIPMENT DESIGNED
TO MEET YOUR PRODUCTION PROBLEMS

Dusenbery

CONVERTING EQUIPMENT



LS CUSTOMIZED CARBIDE-TIPPED SAWS MAKE AMAZING SAVINGS

. . . in the sawing of Plexiglass, phenolics, and other materials because each is fitted to YOUR particular production requirements. "Customized" to give you MAXIMUM PRODUCTION, SMOOTHEST CUTS, MAXIMUM TOOL LIFE and a MINIMUM OF DOWN TIME and COSTS. And because we mean what we say,



WRITE FOR FREE CATALOG

All LS saws are submitted on a fifteen-day free trial basis. Write for Catalog!

LS LEMMON and SNOAP

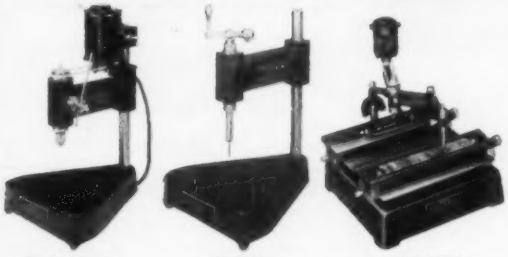
286 BRIDGE ST., N.W. • GRAND RAPIDS, MICHIGAN

24-hour repair service on all makes and styles of carbide-tipped saws

---

MICO "PACKAGE" MACHINE SHOP

For Small Precision Work



DRILL PRESS | TAPPER | ENGRAVER

DRILL PRESS— Accurate, Durable, Sensitive. 1/10 H.P. Universal Ball-bearing Motor. Head and Post Assembly Fits all Mico Engraver Bases.

TAPPER— For Small-Hole Tapping Work. Reduces Tap Breakage, Saves Time. Spindle, With Built-in Tap Chuck, Instantly Removed. Head and Post Assembly Fits Mico Engraver Bases.

ENGRAVER— 2-and-3 Dimensional Pantograph. Maximum of 6-Reduction Ratios. Ball-Bearing Spindle with Micrometer Depth-Control.

ACCESSORIES— Wide Variety of Cutters, Master Type and Holding Devices Available.

Send for FREE "Precision Apparatus" Bulletins

MICO INSTRUMENT COMPANY

80 M Trowbridge Street — Cambridge 38, Massachusetts

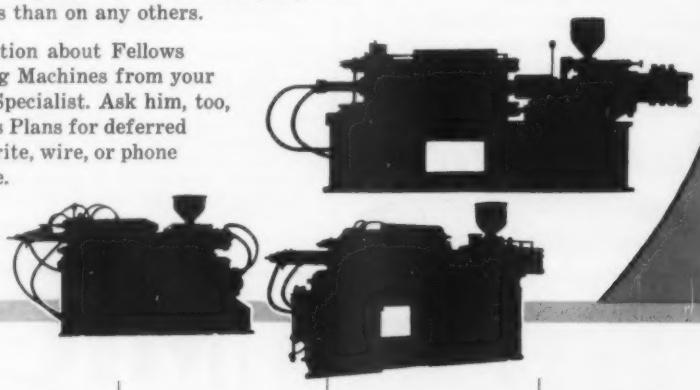
FELLOWS

Fastest Automatic Machines in Each Capacity Range!

In each of three capacity ranges, Fellows Injection Molding Machines are your key to extra profit through high-speed, reject-free, fully automatic operation.

Built-in controls make set-ups fast and relatively simple. Difficult industrial or defense jobs as well as mass-produced consumer pieces, in practically all moldable resins, are produced at lower cost per part on Fellows machines than on any others.

Get full information about Fellows Injection Molding Machines from your Fellows Plastic Specialist. Ask him, too, about the Fellows Plans for deferred payment. Just write, wire, or phone any Fellows office.



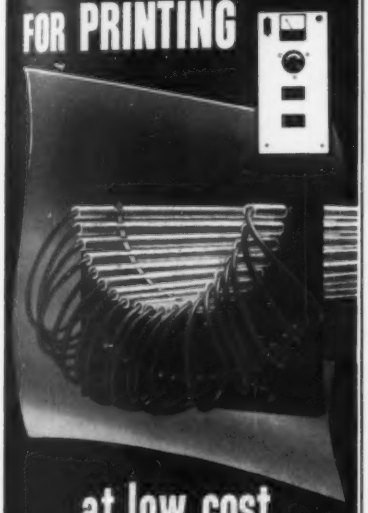
MODEL	3-125	6-200	12-350
Rated Capacity	3 oz.	6-9 oz.	12-20 oz.
Max. Mold Size	12" x 17"	15" x 21"	20" x 32"
Mold Locking Force	125 tons	200 tons	350 tons
Mold Opens	5"-8"	6"-9"	14"
Dry Run Cycles per hour	600-840	490-650	750
H.P.	15	20	40
KW Heater Unit	6	12	20
Plasticizing lbs. per hour	45	75	150

Fellows

injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department: Springfield, Vermont
Branch Offices: 1048 North Woodward Ave., Royal Oak, Mich. • 150 West Pleasant Ave., Maywood, N. J. • 5835 West North Ave., Chicago 39
6214 West Manchester Avenue, Los Angeles 45

TREAT POLYETHYLENE FILM FOR PRINTING



at low cost ELECTRONICALLY

SAVE TIME!! SAVE MONEY!! the revolutionary AETNA electrode (patent pending) simplifies the treating of polyethylene film by bombarding the surface.

NO ADJUSTMENTS—Simply set the single knob remote control and this precision electrode treats film uniformly in any gauge, widths to 66 inches, in strips or overall.

NO DOUBLE-HANDLING—The AETNA amazing electronic treater can be conveniently mounted on any type of extruder to produce treated film in one simple operation.

NO MAINTENANCE PROBLEMS — No more daily servicing! Simply install this small, compact, low-cost unit wherever desired and forget about it.

NO BURN THROUGH—This scientifically precise method guarantees safe, sure results every time as part of actual printing or extruding operations.

For further information write or wire today.

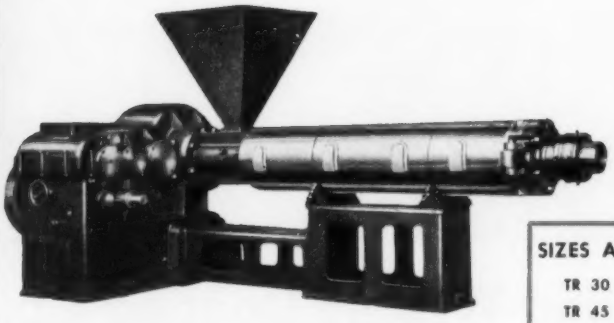
AETNA

ELECTRONICS CORP.
207 Stonehinge Lane
Carle Place • Long Island, N.Y.
EDgewood 3-1062

new design

LUIGI-BANDERA EXTRUDERS

CONVENIENT PRICE
WELL DESIGNED MACHINES
COMPLETE WITH ACCESSORIES
FOR ALL KINDS OF EXTRUSIONS



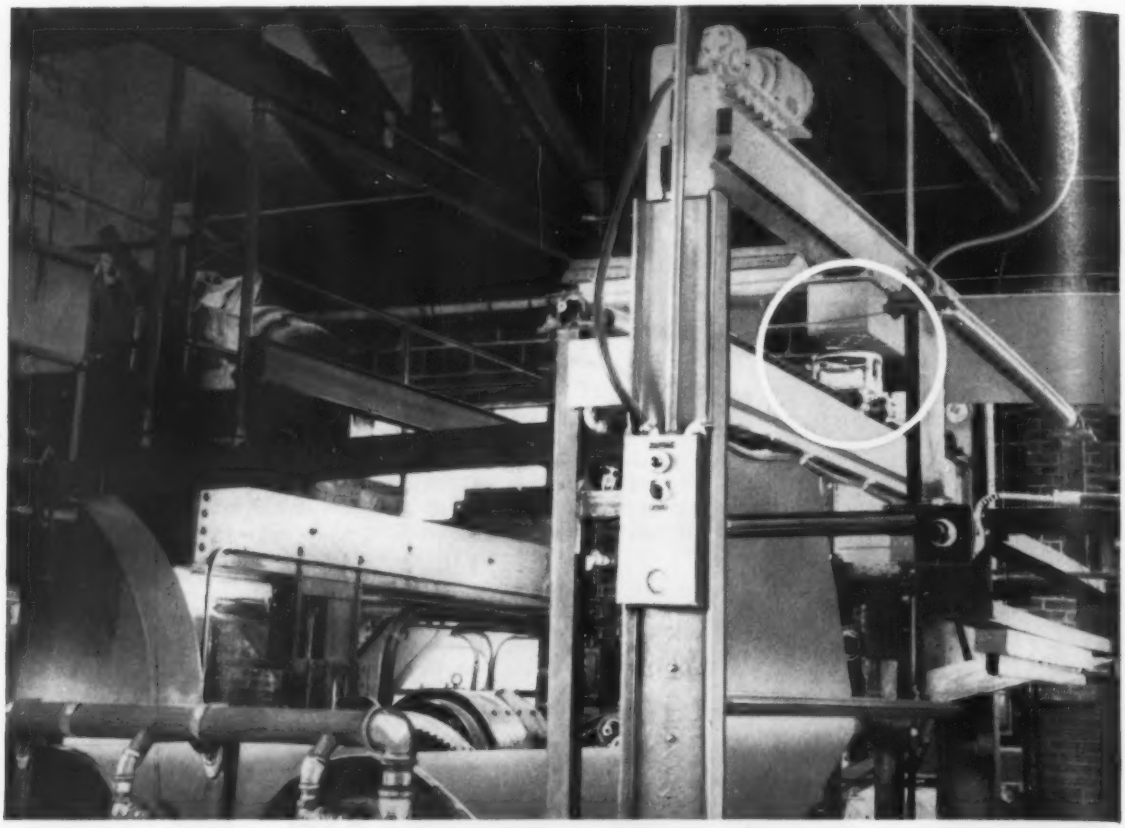
SIZES AVAILABLE	
TR 30	—1¼"
TR 45	—1¾"
TR 60/2	—2½"
TR 80	—3¼"
TR 100	—4"
TR 120	—4¾"
TR 160	—5¼"
TR 200	—8"

Amongst our 8 types there is surely that one suiting your necessity. We have also the accessories for: wire and cable coating, extrusion of profiles in every shape, calibrators, pullers and cutters for rigid PVC tubes as as well as polyethylene with winder, plants for lay flat tubings in polyethylene and PVC, granulators etc.

World distributors:
COVEMA s.r.l.—Milano (Italy)
Via Fontana 5—Tel. 705.735-709.356

The Rainville Company inc.

sole agents for U.S.A.
New York (N.Y.) 224 Seventh St., Garden City
Alhambra (Calif.) 1420, South Garfield Avenue
Tel. AT 4-3940—CU 3-4465



Curtiss-Wright Coating Control System



Operator adjusts controller to proper specification for each order.

Insures "On Spec" Production for Federal Industries

Car upholstery of modern plastic boasts longer wear, brighter colors, a variety of grains and textures. Federal Industries division of Textron, Inc., Belleville, N. J., is a leading manufacturer of plastic coated upholstery fabric for the automotive industry. To maintain continuous quality and "on spec" production, Federal has installed a Curtiss-Wright Non-Contact Coating Control System for complete uniformity on every run.

This system monitors coated stock continuously. Any variation from proper weight or thickness specified for each order is caught by the nuclear transverse scanner and shown instantly on the target meter and chart recorder. Correction adjustments are simple and sure, scrap losses reduced, time and raw materials saved.

Whatever your type of plastic film, sheet or coated stock manufacturing operation, a Curtiss-Wright Non-Contact Coating Control System with custom-designed installation can effect savings and increase quality production. Write for complete details and application information.

WEST COAST REPRESENTATIVE:
Western Dynamics Co., 444 Dexter Horton Bldg., Seattle 4, Wash.

CANADIAN REPRESENTATIVE:
Electronics Associates, Ltd.
4616 Yonge St., Willowdale, Ont.

Systems Frieseke & Hoepfner

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.



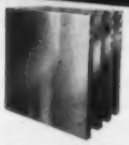
LAKE ERIE Molding Presses

Standard and Custom-Built from 15 to 5000 tons

Lake Erie offers a complete line of compression, transfer, laminating and laboratory molding presses. The many designs include automatic, semi-automatic and manually operated models . . . multi-unit, self-contained and accumulator operated types. Presses manufactured by Lake Erie are noted for their sturdy construction, fast operation and reliable performance.

HIGH-TONNAGE PRESSES

Hydraulic presses with capacities up to 22,000 tons are manufactured by Lake Erie. This experience with heavy equipment enables Lake Erie to furnish big, high-tonnage presses of *tested design* to molders who need equipment capable of *producing efficiently* the giant-size moldings now being ordered by many customers.



STEAM PLATES . . . available in sizes up to 80" wide in any length desired.

LAKE ERIE MACHINERY CORPORATION, successor to

LAKE ERIE ENGINEERING CORP.

• Manufacturers of the most complete line of hydraulic presses for all industries including presses for hobbing and die sinking, and plywood and hardboard production.

869 Woodward Avenue, Buffalo 17, New York LAKE ERIE®

LAKE ERIE
MACHINERY CORP.
BUFFALO, N.Y. U.S.A.

DISTRICT OFFICES IN: NEW YORK • CHICAGO • DETROIT

WATLOW ELECTRIC HEATING UNITS FOR ALL MOLDING OPERATIONS

INJECTION EXTRUSION MOLDING



Watlow NARROW BANDED Heaters

- Constant, unvarying heat.
- Fewer burnouts.
- Easy installation or replacement.

Write for Bulletin 570

COMPRESSION MOLDING



Watlow FIREROD Cartridge Heaters

5 TIMES MORE HEAT THAN ANY STANDARD CARTRIDGE HEATING UNIT

- A new high in watts densities and temperatures.
- L-e-n-g-e-r cartridge life.
- Same heat as a standard cartridge, in a unit 1/5th the size — an important design advantage.

Write for Bulletin 365

VACUUM MOLDING



Watlow WATROD Tubular Heaters

- High temperature inconel sheath for radiant heat in vacuum forming operations.
- Equal in quality to the famous Watlow Narrow-Banded units, used extensively in injection molding equipment.

FREE CATALOG-HANDBOOK!
How to select, apply and install electric heating units; useful data on sizes, materials, uses, etc.

SALES REPRESENTATIVES in principal cities. Consult your classified telephone directory — or write home office.

WATLOW ELECTRIC MANUFACTURING CO.
1382 FERGUSON AVENUE
SAINT LOUIS 14, MISSOURI

WILLIAMS-WHITE HYDRAULIC MOLDING PRESSES

for Better Products



REPRESENTATIVES

ALLIED NORTHWEST MACH. TOOL CORP.
Portland, Oregon
A. L. BECHTEL & SON
Cleveland, Ohio
GEORGE A. DAVIES MACH'Y. CO.
Los Angeles, California
SEIFREAT-ELSTAD MACH'Y CO.
Cincinnati, Columbus or Dayton, Ohio
EDWARD A. LYNCH MACH'Y. CO.
Wynnewood, Philadelphia, Pennsylvania
PAGEL MACH'Y. CO
Milwaukee, Wisconsin
PERINE MACH'Y. & SUPPLY CO.
Seattle, Washington
FRANK RYMAN'S SONS
Pittsburgh, Pennsylvania
WILLIAMS-WHITE & CO.
53 W. Jackson Blvd., Chicago, Illinois
E. E. WOOD MACH'Y. CO.
Detroit, Michigan

WILLIAMS-WHITE & Co.
300 EIGHTH ST. • MOLINE, ILLINOIS
PRESSES • BULLDOZERS • BENDERS • PUNCHES • SHEARS

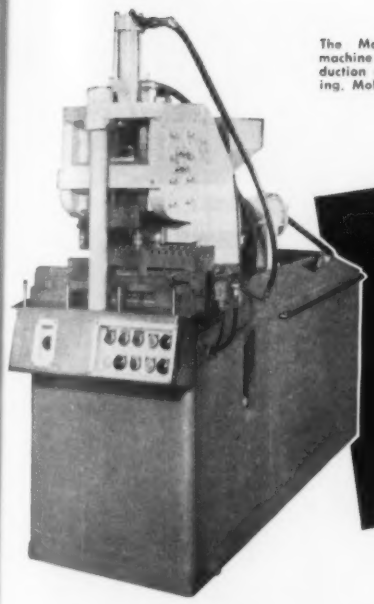
A battery of SIX 113-Ton Hydraulic Presses with hydraulic pressure furnished by ONE pumping unit and ONE motor!

The hydraulic circuit is so designed that pressure is maintained in five presses while the sixth is opening or closing. Automatic cycle control of each press is by pushbutton and adjustable timer.

This system represents considerable reduction in initial and maintenance costs by eliminating the expensive, space-consuming accumulator while retaining its desirable features.

For full information, see our Representative or write us direct.

BUILDERS OF MACHINERY SINCE 1854



The Moslo DUPLIMATIC—2½ ounce machine designed for high speed production of cord plugs and insert molding. Molds all Thermo-Plastic materials.

MOSLO INJECTION PLASTIC MOLDING MACHINES

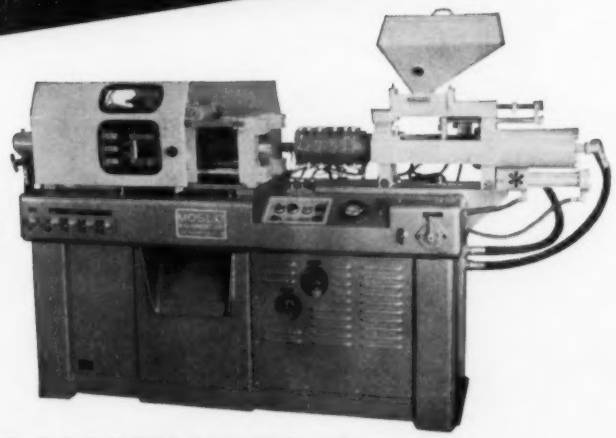
Out-produce other machines with TWICE the rated capacity

It may sound unbelievable, but it is a fact that Moslo injection molding machines turn out twice the production of similar competitive machines.

Moslo machines are equipped with the latest automatic controls and safety features, are ruggedly constructed for years of continuous running, and operate at speeds that make *production profitable.*

To appreciate fully how a Moslo machine can benefit you, write for complete specification material.

Better yet, make a visit to our headquarters and we will arrange a demonstration using your own molds.



The Moslo Model 74-7-2—2 ounce injection molding machine. **



The Moslo Model 75-8-4—4 ounce injection molding machine. **

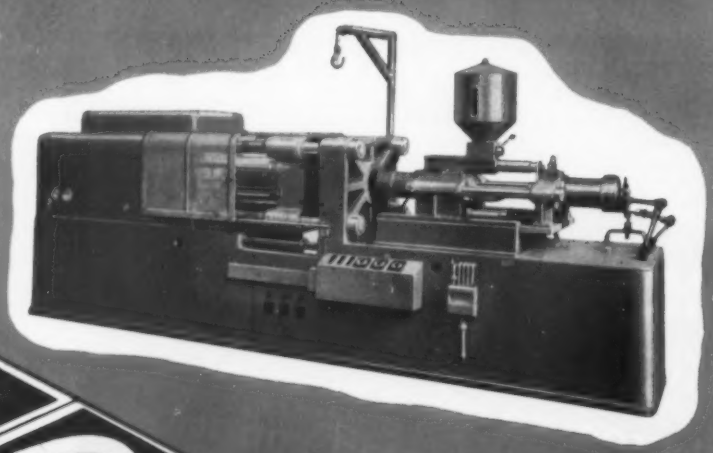
*Hydraulic pull-back for plasticizing assembly is optional equipment on 2 ounce model and standard equipment on Model 75.

**2 and 4 ounce machines available with long stroke clamp for deep-draw work as optional equipment.

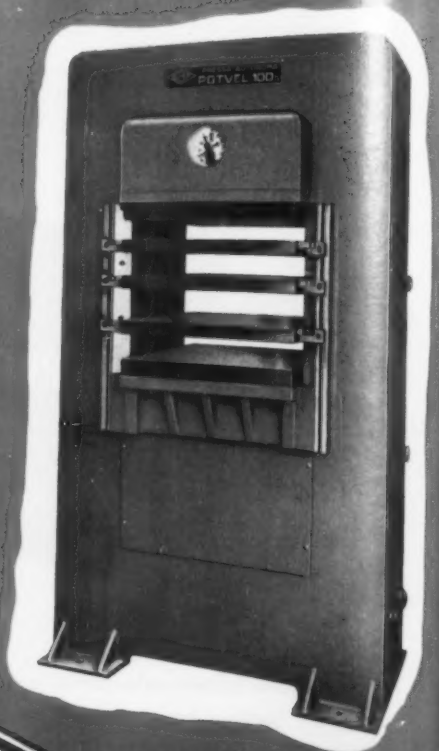
MOSLO — The Name for the world's fastest Molding Machines

MOSLO MACHINERY COMPANY

2437 PROSPECT AVENUE • CLEVELAND 15, OHIO



Injection Moulding Machine
capacity: 1, 2, 4, 6, 10 oz.



Multiple Platen Press
for Rubber and Lamination
capacity: 62, 100, 200, 300, 600 tons

GBF GBF GBF GBF GB

s.r.l. costruzioni meccaniche

ufficio commerciale: via Fontana 5 - MILANO - tel. 705.735 - 709.356
stabilimento: via Vittorio Veneto 12 - BRESSO - MILANO (Italy)

Low Pressure Press for
Reinforced Plastics
capacity: 35, 62, 100, 200 tons





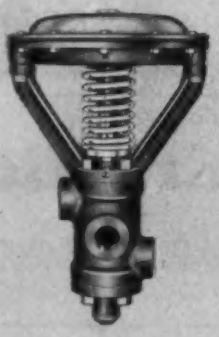
Compression Moulding Press
for Thermosetting Materials
capacity: 35, 62, 100, 195, 270, 500 tons

Machines for

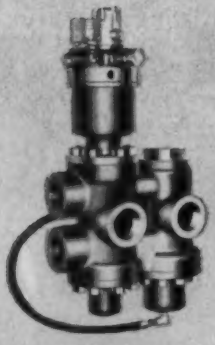
Plastic

Materials

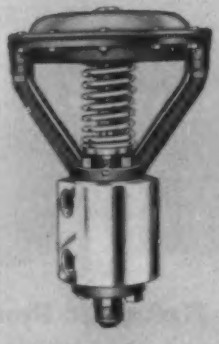
for push button automatic control . . . faster action . . . trouble-free service . . .



4000 PSI BALANCED 3 WAY VALVE



3000 PSI 4 WAY HYDRAULIC VALVE



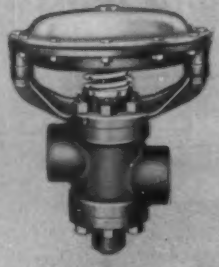
6000 PSI BALANCED 3 WAY VALVE

SPECIFY

SINCLAIR-COLLINS

DIAPHRAGM-OPERATED CONTROL VALVES

2, 3 and 4 way • single or two pressure • high or low pressure — air operated, oil operated • for oil, air, steam, hot or cold water service • remote manual or automated control



4000 PSI 2 WAY VALVE —DIRECT ACTING —NORMALLY OPEN TYPE



4000 PSI 2 PRESSURE, HYDRAULIC OPERATING VALVE—AUTOMATIC HIGH PRESSURE

Any rubber or plastic processing equipment you manufacture or operate will perform better—at lower cost—with Sinclair-Collins valves!

Shockless inlet and release pressures, Stellite valve stem seats, replaceable hardened stainless steel seat sleeves, cast navy bronze (4000 psi) or hi-tensile bronze alloy billet (6000 psi) valve bodies which resist the corrosive action of water and high velocity hydraulic fluids . . . all these features add up to peak, trouble-free performance and lower maintenance costs!

Consider your high pressure valve requirements carefully. Then call in your nearby Sinclair-Collins representative. You'll find that he can supply your valve needs *exactly* . . . in sizes from ½ to 3 in. . . . all available for fast delivery from stock. Write for brochure. The Sinclair-Collins Valve Company, 454 Morgan Avenue, Akron 11, O.

AA-1103

Representatives in principal cities

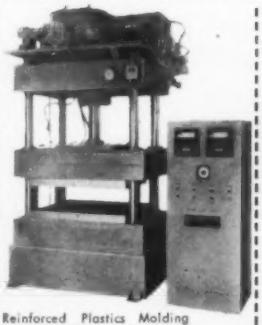
THE SINCLAIR-COLLINS VALVE COMPANY

454 Morgan Avenue • Akron 11, Ohio

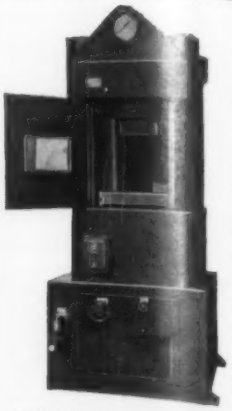
Compression Molding | Transfer Molding

Reinforced Plastics | Laminating & Hobbing

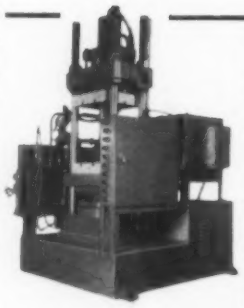
M & N Hydraulic Presses



Reinforced Plastics Molding Presses. Capacities: 25 tons to 500 tons. Platen Sizes 18" x 18" to 4' x 8'



Hobbing Presses
Capacities: 100 tons to 2000 tons



Semi-Automatic Presses
Transfer or Compression Molding
Capacities: 10 tons to 500 tons
Platen Sizes: 12" x 12" to 30" x 30"

Fast, accurate and dependable—these are the reasons so many manufacturers prefer M & N Hydraulic Presses. The many models include hand-operated, semi-automatic and all-automatic control systems . . . feature special "V" packed ram that eliminates leakage problems and minimizes friction losses. Fully instrumentized presses available for high or low temperature plastics applications . . . offering precise control of time, temperature and pressure.

Units available with—power or gravity return platen—pressure regulator—adjustable crown—automatic horse-power reduction during curing cycle—single or multiple platens—upper and lower "knockouts"—rapid speed advance stroke with adjustable automatic slowdown—electrically heated or steam heated platen arrangements.

Whatever your hydraulic press requirements—get full details and cost comparisons from M & N . . . you will find that it pays.

Presses Built to Order for Special Applications



Write for Complete Information

M & N Modern Hydraulic Press Co.

779 ROUTE 3, CLIFTON, NEW JERSEY

THE THROPP 60" MILL *designed and built for*

MAXIMUM EFFICIENCY—SUPERIOR PERFORMANCE —MINIMUM MAINTENANCE

This extra heavy duty 60" streamlined mill is designed and built in every detail to provide dependable uninterrupted production under the rigorous service conditions encountered in the Rubber and Plastics Industries.

Built-in herringbone gear speed reducers, mounted on anti-friction roller bearings, insure proper alignment with master gear and pinion at all times. Fully enclosed frames and guards keep cleaning and maintenance costs down.

Thropp 42", 50", 72" and 84" mills for the Rubber and Plastics Industries are also available.



• Thropp 22" x 22" x 60" Mill

Send for further information.

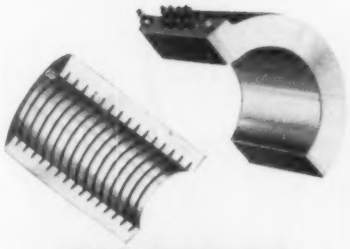
Wm. R. THROPP & Sons

Division of J. M. LEHMANN COMPANY, Inc.
372 NEW YORK AVE., LYNDHURST N. J.

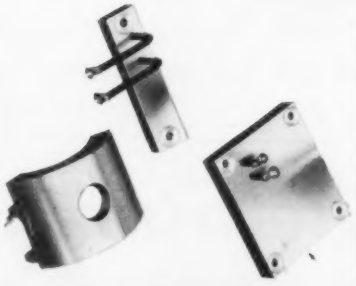
THERMEL®
Engineered Heat
has solved many of the toughest jobs in the Plastics Industry!

THERMEL "Custom-Built" jobs are constantly turned into *Standards* that are accepted in the Industry!

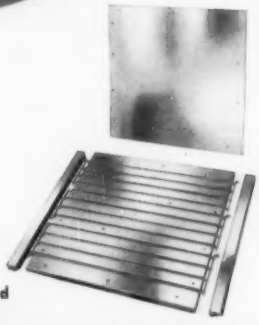
- ***. . . FOR EXTRUSION***
  Thermabands — Die Heaters
- ***. . . FOR INJECTION MOLDING***
  Thermabands (Cast and Strip)
- ***. . . FOR COMPRESSION MOLDING***
  Thermoplatens (Cast and Steel)
- ***. . . FOR VACUUM DRAWING***
  Radiant Thermatubes — Radiant Cast Platens
- ***. . . FOR PACKAGING — SEALING***
  Cast Heaters — Tubular and Cartridge Elements



THERMABANDS

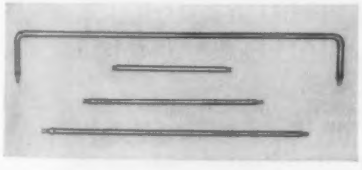


THERMAHEATERS



Exploded View

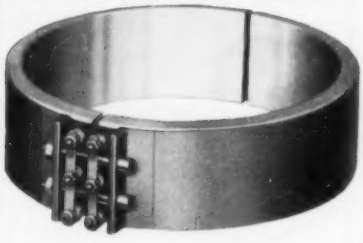
THERMAPLATENS



RADIANT THERMATUBES



THERMATUBES



THERMASTRIP BANDS

BRING YOUR PROBLEMS TO US — NONE TOO LARGE — NONE TOO SMALL

Thermel, inc. 9408 Robinson Road, Franklin Park, Illinois
"A Suburb of Chicago"

1005

A

A JOY TO OPERATE

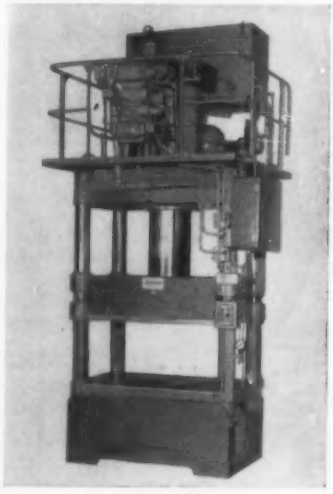
Lawtomatic

A PROFIT TO OWN

Hydraulic

PRESSES

C FRAME
AIR HYDR.
METAL DRAW
COMPRESSION
TRANSFER
•
COMPACT DESIGN
•
DEPENDABLE WORKERS



(200 TON)

Hydraulic

CYLINDERS

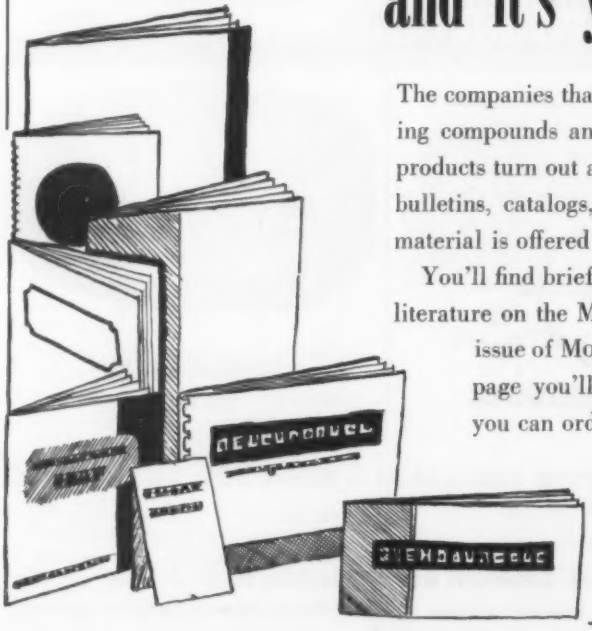
ALLOYED IRON
MEEHANITE
STEEL
BRONZE
•
STURDY CONSTRUCTION
•
POSITIVE CONTROLS

Reinforced Plastic Molding Press

THE C. A. LAWTON COMPANY – DePere 1, Wisconsin

Helpful literature . . .

and it's yours for the asking!



The companies that supply the equipment, resins, chemicals, molding compounds and services used in the manufacture of plastics products turn out a continuing stream of valuable and informative bulletins, catalogs, manuals, and technical reports. Much of this material is offered without charge to interested businessmen.

You'll find brief descriptions of about four dozen pieces of such literature on the Manufacturers' Literature Page of each monthly issue of MODERN PLASTICS magazine . . . and on the same page you'll find a detachable prepaid postcard on which you can order the specific items you want—*free.*

Next issue you get, turn to the Manufacturers' Literature Page . . . and use it!

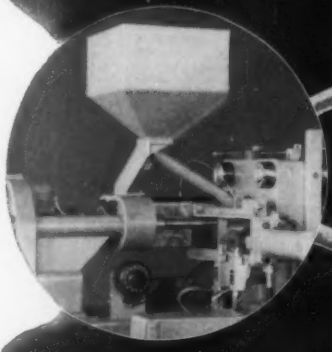
MODERN PLASTICS

A BRESKIN PUBLICATION

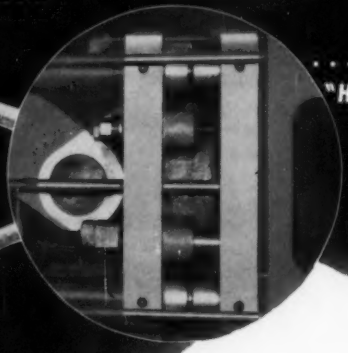
Only the LEWIS "6P"

INCLUDES AS STANDARD . . .



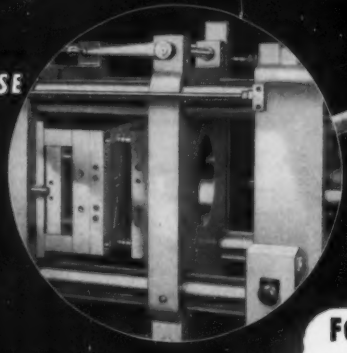


. . . AN EXCLUSIVE NEW PRE-PLASTICIZER



. . . 200-TON "HYDRA-LOCK" CLAMP

. . . QUICK-RELEASE DIE-LOCK DEVICE



. . . NEW SPEEDS, CAPACITIES, VERSATILITY

FOR DETAILS AND PRICES . . . write today or call BEdford 2-2500.

LEWIS

THE LEWIS WELDING & ENGINEERING CORP.

Machine Division

102 NORTHFIELD ROAD • BEDFORD, OHIO

FOR GREATER PROFITS IN PRODUCTION MOLDING

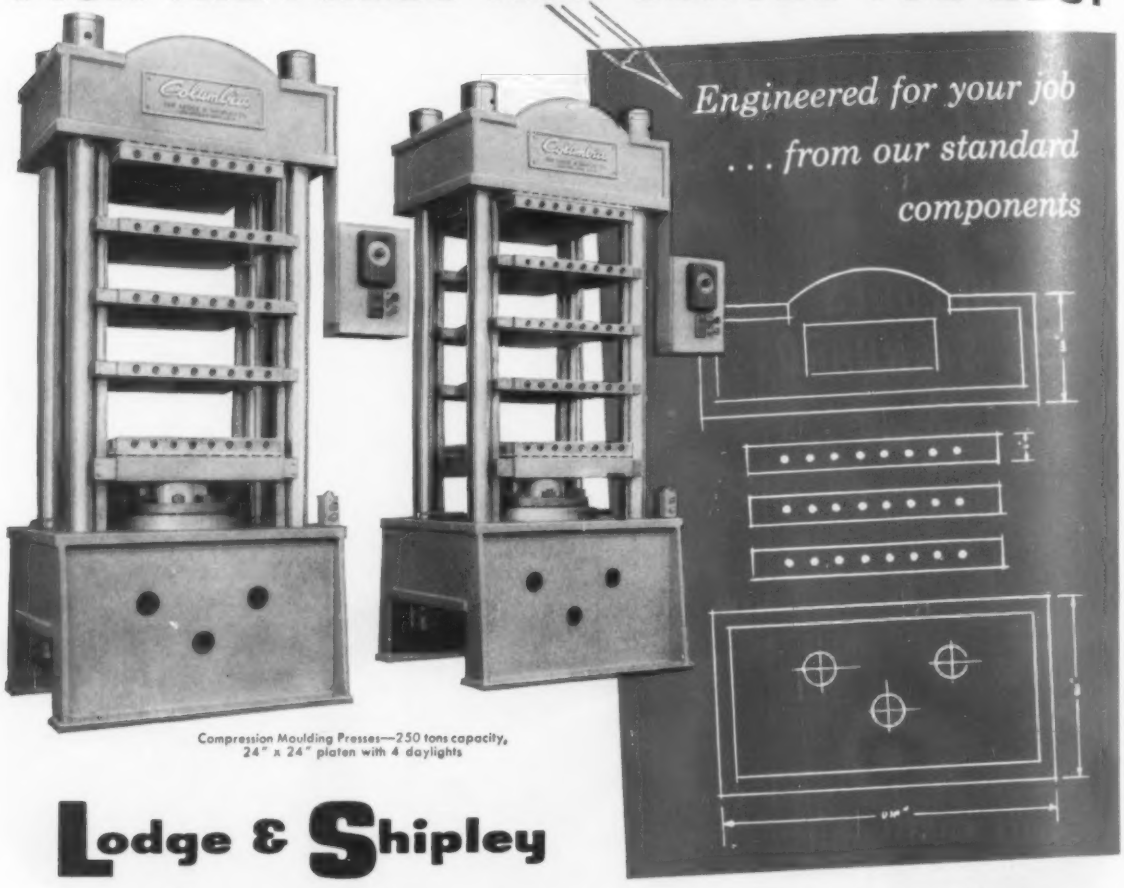
The LEWIS pre-plasticizer scores two "firsts". (1) It was developed especially for an 8-ounce machine. (2) It is furnished as *standard equipment.*

A new concept in pre-plasticizer design, this unit gives molders unprecedented capacities and flexibility of operation. Because of its extremely precise temperature control, it permits intermittent operation without flashing or burning . . . can operate at greatly decreased injection pressures and temperatures. In fact, MODEL "6P" is the first machine capable of molding the new low-pressure linear-type polyethylenes as well as other materials.

The LEWIS "6P" is more than an "improved" model . . . *it is the most versatile production machine ever offered at competitive prices in the 8-ounce class.*

7360-LWM

PICK THE PRESS THAT SERVES YOU BEST



Compression Moulding Presses—250 tons capacity, 24" x 24" platen with 4 daylights

Lodge & Shipley

hydraulic compression moulding presses

Pick the press that will serve you best! Lodge & Shipley Hydraulic Compression Presses are job-proved for easy operation, high output, quality production and minimum maintenance. And the price is low!

Among outstanding features praised by users are:

TROUBLE-FREE HYDRAULIC SYSTEM . . . special welded fittings and seamless tubing

AUTOMATIC AIR-BLEEDING VALVE . . . eliminates dangerous manual bleeding task

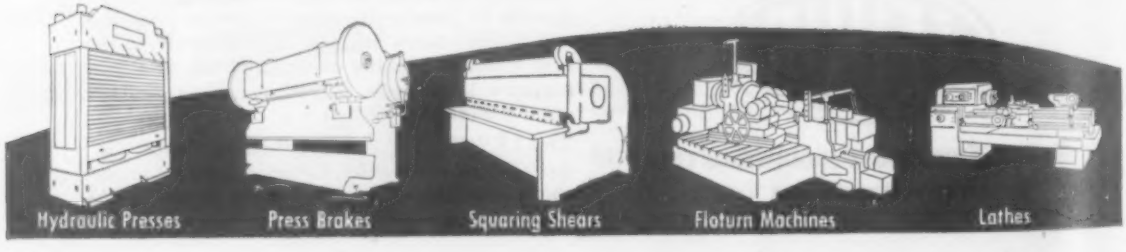
UNITIZED PUMP . . . reservoir, pump, valves, gauges . . . all in one compact unit

CONVENIENT CONTROLS . . . handily mounted "open" and "close" push buttons

PRECISION CONSTRUCTION . . . for more production, fewer rejects

See for yourself . . . write for FREE Bulletin HP-14 with complete details:

THE LODGE & SHIPLEY CO.
3066 Colerain Ave., Cincinnati 25, Ohio



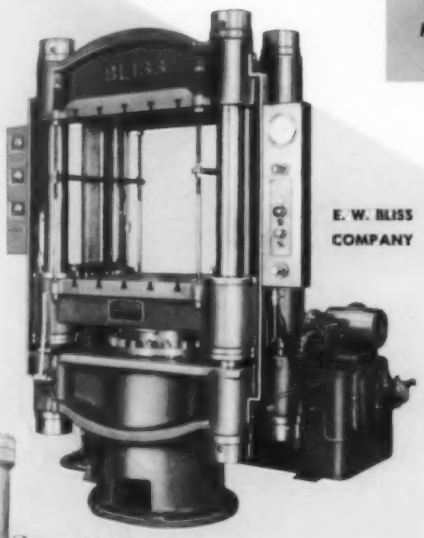
VICKERS

Hydraulic Controls

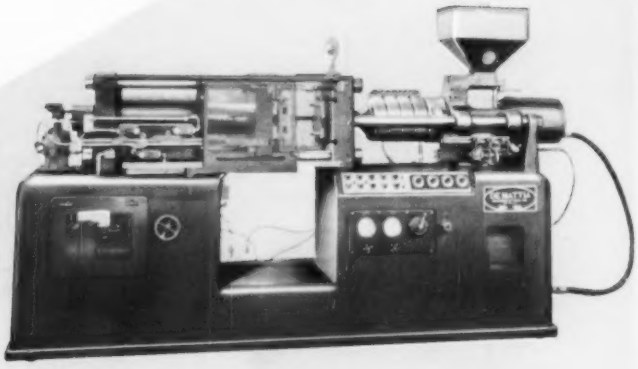
an all-important component of modern high production

PLASTIC MOLDING MACHINERY

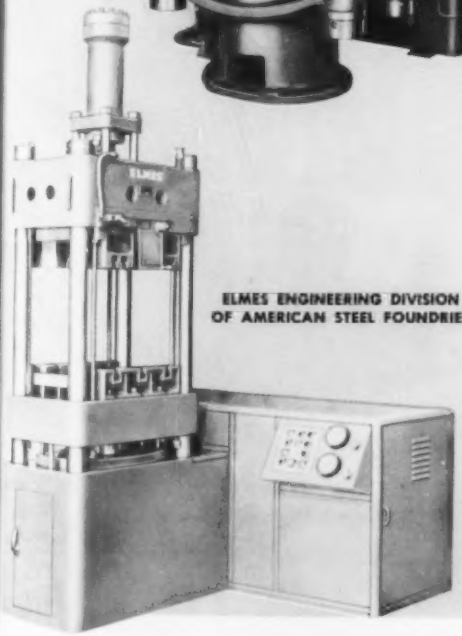
TONS OF POWER IN SPLIT-SECOND TIMING CYCLES



E. W. BLISS COMPANY

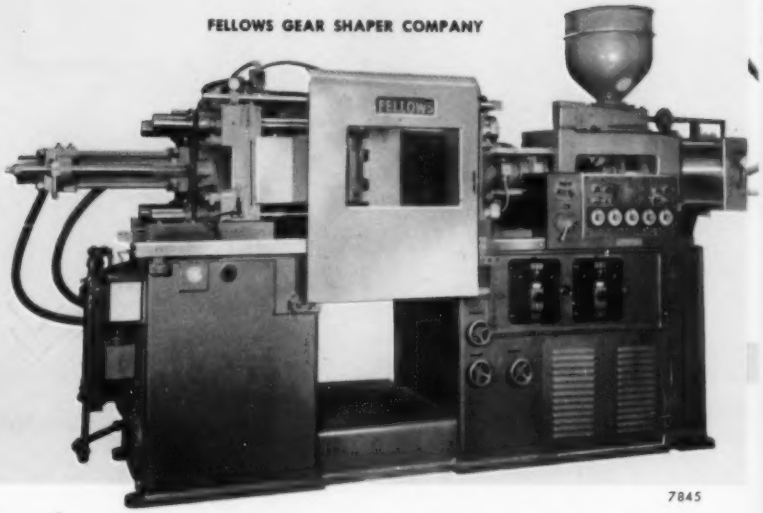


DE MATTIA MACHINE & TOOL CO.



ELMES ENGINEERING DIVISION OF AMERICAN STEEL FOUNDRIES

FELLOWS GEAR SHAPER COMPANY



7845

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1400 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto and Montreal

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

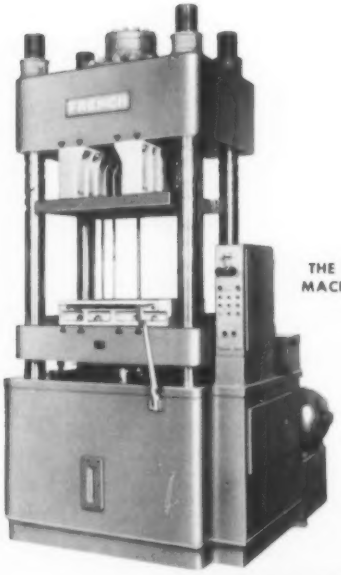
VICKERS® Hydraulic Controls

The modern plastic molding machines illustrated here are representative of the many that use Vickers hydraulic equipment. Vickers hydraulic pumps are ideally suited to this type of machinery, providing dependable service and economy of operation for a wide range of cycling speeds and tonnage requirements. In addition, Vickers valving, which is suitable for almost every pressure and control purpose, assures the unvarying control that means product uniformity. The fully automatic control provided speeds production and cuts costs.

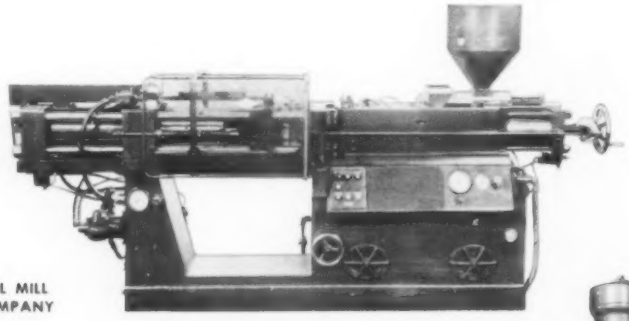
Flexibility is another important characteristic of Vickers Hydraulic Controls. The control cycle on Vickers-equipped machines can be altered easily to accommodate changes in material characteristics and product requirements. Yet when established, the new control cycle is always followed precisely. Thus, a Vickers-equipped machine will provide the most economical production cycle for a wide variety of parts and conditions.

Vickers Hydraulic Controls can automatically protect the machine against excessive pressure due to mechanical failure or improper material characteristics—against mistakes and abuse.

Vickers Hydraulic Controls are important components of modern, high-production plastic molding equipment.

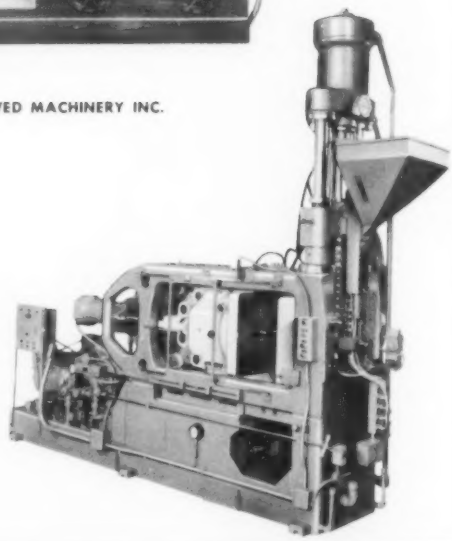


THE FRENCH OIL MILL MACHINERY COMPANY



IMPROVED MACHINERY INC.

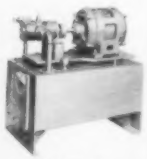
LESTER-PHOENIX, INC.





LAKE ERIE MACHINE CORPORATION

representative standardized Vickers units



Hydraulic Power Unit



Two-Stage Pumps



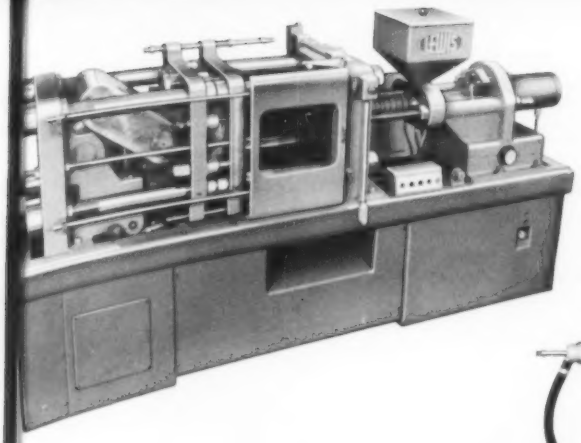
Variable Delivery Pumps



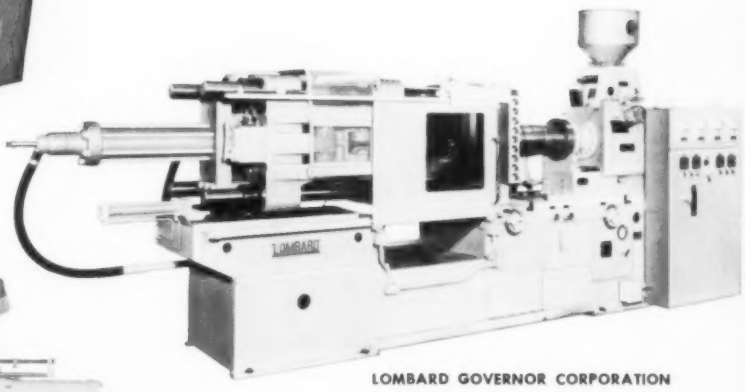
Solenoid Operated Four-Way Valve

PLASTIC MOLDING MACHINERY

TONS OF POWER IN SPLIT-SECOND TIMING CYCLES



LEWIS WELDING & ENGINEERING CORP.

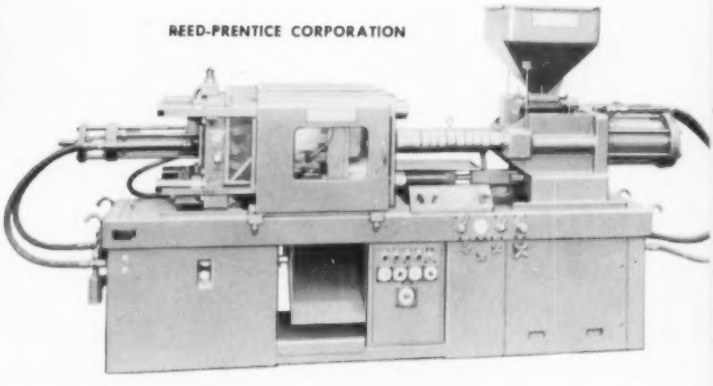


LOMBARD GOVERNOR CORPORATION



MOSLO MACHINERY COMPANY

REED-PRENTICE CORPORATION



for every hydraulic power and control function (See Catalog No. 5001B)



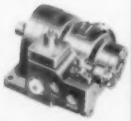
Relief Valves



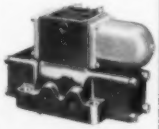
Sequence Valve



Pilot Valves (Plunger Type)



Two-Pressure, Large-Small Volume Pumps



Solenoid Control Pilot Operated 4-Way Valves



Pilot Valves (Rotary Type)



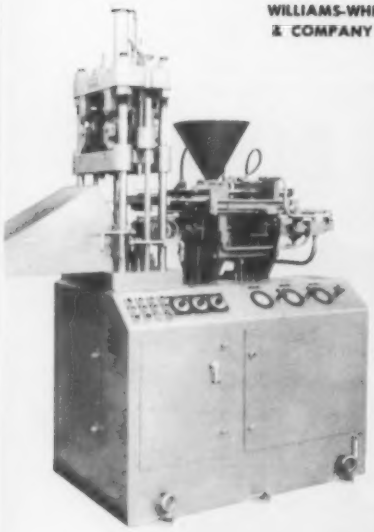
Adjustable Flow Control Valves



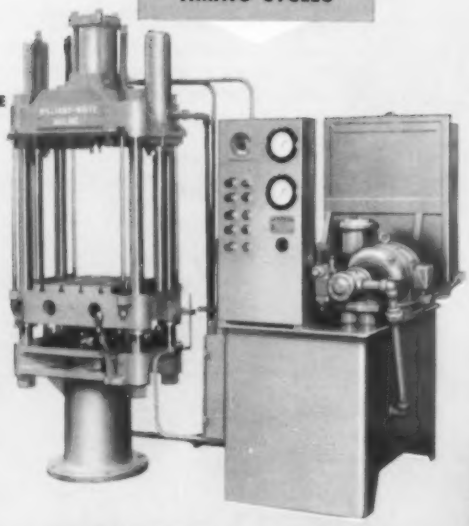
Custom Built Hydraulic Power Un

VICKERS®
Hydraulic Controls

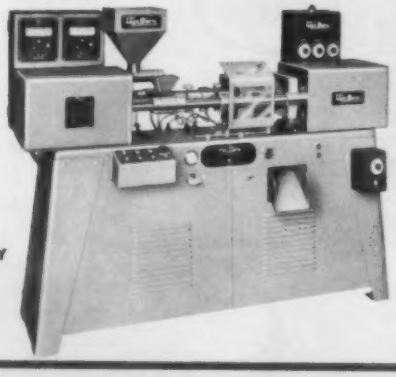
TONS OF POWER IN SPLIT-SECOND TIMING CYCLES



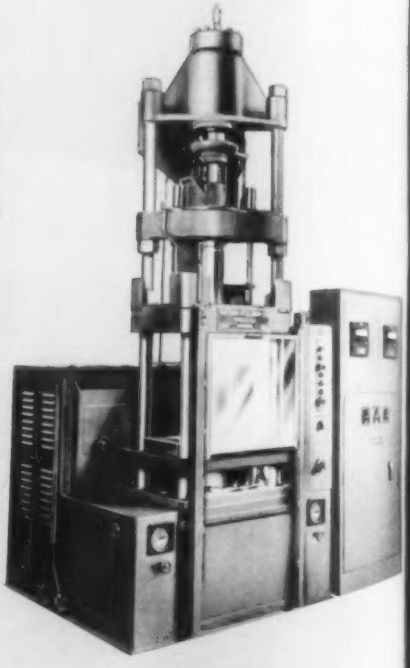
F. J. STOKES CORPORATION



WILLIAMS-WHITE & COMPANY



VAN DORN IRON WORKS COMPANY



WATSON-STILLMAN PRESS DIVISION

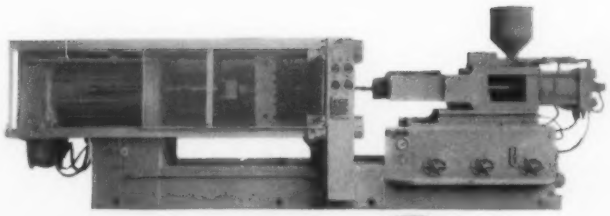
Vickers New Administrative and Engineering Center
Dedicated to the Development and Improvement of Hydraulic Components and Systems



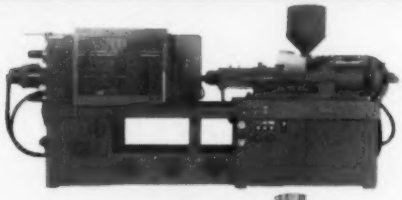
VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1400 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto and Montreal

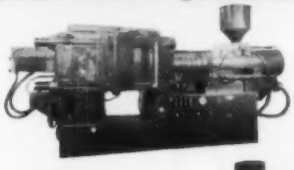
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



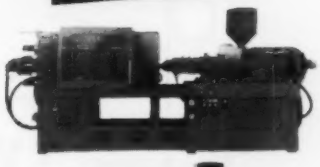
HA 28-600
28-32 Ounces
100 Ounces with
Preplasticizer



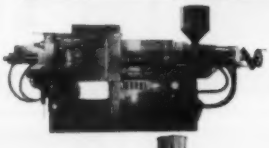
HA 16-425
16-20 Ounces



HA 12-300
12-16 Ounces



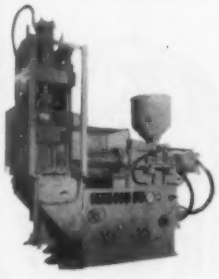
HA 8-275
8-10 Ounces



HA 4-175
4-6 Ounces



HA 2-125
2-3 Ounces



VA 4-175-19
4-6 Ounces

IMPCO®

PLASTIC MOLDING MACHINERY

Injection Machines
Compression and Transfer Machines
Preplasticizers
Mold Temperature Controllers
Special Machinery for
Molding Applications

IMPROVED
MACHINERY INC.

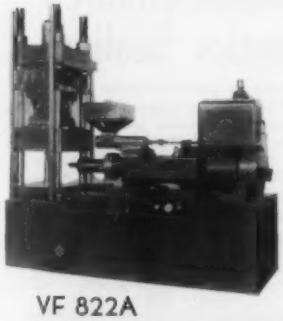
Nashua, New Hampshire

In Canada, Sherbrooke Machineries Limited
Sherbrooke, Quebec

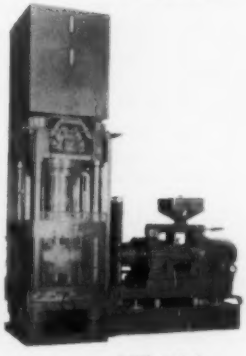
Export Distributors: Omni Products Corp.
460 Fourth Avenue, New York, New York



VF 1.5
1-3 Ounces



VF 822A
16-22 Ounces
80 Ounces with
Preplasticizer



VF 800
32-48 Ounces

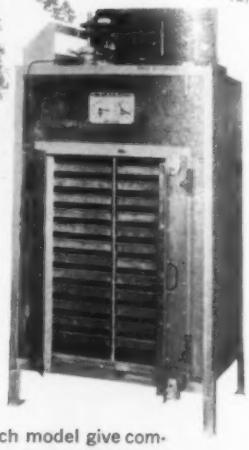


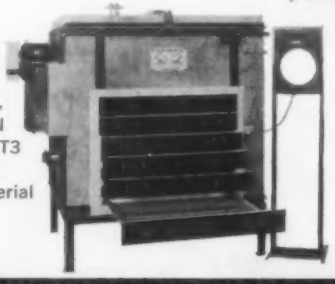
ELECTRICALLY HEATED OVEN
—800°F.—60 KW
FOR TEFLON SINTERING
(Model 4352—T8)

LYDON

DEPENDABLE, HIGH QUALITY OVENS AND DRYERS FOR PLASTICS

CABINET TRAY DRYER (Model 1[illegible]0—T2)





DRAWER TYPE, CABINET OVEN
(Model 1327 D—T3
For preheating thermoplastic material

Separate bulletins for each model give complete details, features and specifications.

LYDON Bros., Inc.

87 Zabriskie Street, Hackensack, N. J.

OFFERING THE EXPERIENCE OF 25 YEARS AND MORE THAN 3000 INSTALLATIONS



. . . They're Engineered for Your Specific Requirements

First we analyze your problem. Then we give you a "complete winding package" — tailor made to your needs — including motor, winder, stands and all other accessories.

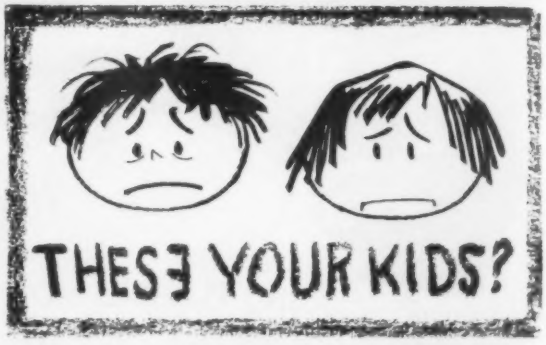
We make 5 different types of winders for handling webs, sheets and single strands. One of them is surely adaptable to your needs.

Get more information. Write for the
HOBBS-ALQUIST BROCHURE

HOBBS MANUFACTURING CO.
55 Salisbury St., Worcester 5, Mass.

Representatives in: Irvington, N. J.; Chicago, Ill.; Cleveland, O.; Granville, S. C.; Toronto, Ont.

Winders • Hand & Power Shears • Die Presses • Slitters • Corner Cutters



We Treat" Problem Children" in Sheet Plastics Sealing

Some of the biggest names in American industry have used the faculties and facilities of this highly specialized organization to overcome seemingly impossible sealing problems. Whether you install one or more Mayflower stock presses or generators or have us build custom engineered equipment, you have the assurance that this unique service is at your command . . . any time, anywhere.

We invite your inquiries

Mayflower ELECTRONIC DEVICES Inc.

Only Manufacturer of both Bar and Rotary Electronic Heat Sealers

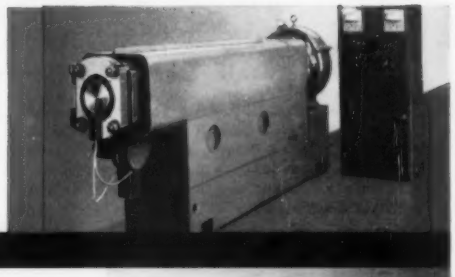
HUbbard 9-9400

20 Industrial Avenue Little Ferry, N. J.

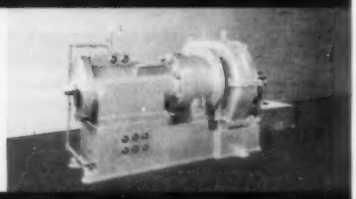
Xaloy

bimetallic heavy wall extruder cylinders

WORLD'S TOUGHEST...LONGEST LASTING LINERS AND BARRELS

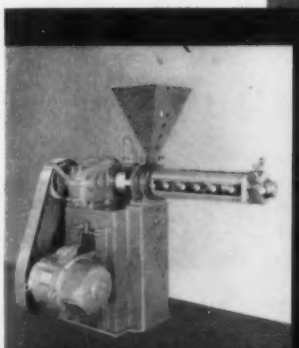


Xaloy liners are fabricated to this broad range of design specifications



Xaloy bimetallic cylinders readily adapt to every extruder design—are manufactured to individual specifications.

Xaloy and Xaloy 306 have been developed with specific hardness and abrasion resistance properties to protect extruder cylinders from severe and destructive actions of thermoplastics and compounds used in plastics and rubber extrusions.



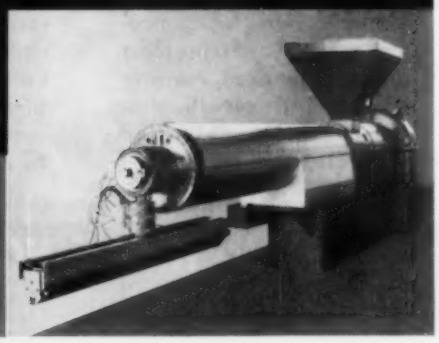




Write for Xaloy Engineering and Data Guide

WORLD'S LARGEST FACILITIES DEVOTED EXCLUSIVELY TO EXTRUDER LINERS AND EXTRUDER BARRELS

BIMETALLIC Xaloy 306 CORROSION RESISTANT



INDUSTRIAL RESEARCH LABORATORIES
DIVISION OF HONOLULU OIL CORPORATION
961 E. Slauson Ave., Los Angeles 11, Calif., U.S.A.

BIMETALLIC Xaloy ABRASION RESISTANT



DIE SINKING — MOLD MAKING MACHINERY

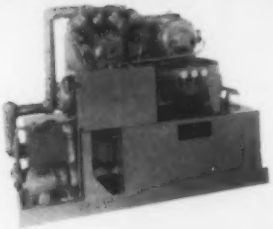
Tracer-Controlled Gorton Pantographs, Die and Mold Duplicators and special machines constantly make important contributions to your industry. The illustration shows how an intaglio design is transferred from an enlarged master to the work piece for fast, low-cost production of a high-quality mold for the plastic cover of a silverware chest. This is one of many examples of special operations that make the Gorton Pantograph almost indispensable in many plastics plants.

Now ready for you: concrete evidence of Pantograph versatility — from tiny pieces on up.

Write for Bulletin 2070-A.

GEORGE GORTON MACHINE CO., 1320 Racine Street, RACINE, WIS., U. S. A.

MAYER **Has It!** COOLING EQUIPMENT DESIGNED FOR QUALITY CONTROL AND ECONOMY OF PLASTIC PROCESSING OPERATIONS



Chil-er Recirculating Units for . . .

Circulation of chilled process water for injection molds, extruders, cooling baths; printing rolls, embossing rolls, calandar and mill rolls.



Dip-Cooling Baths for . .

Instant chilling of molded plastic forms with heavy cross sections, to prevent 'sinks', distortion and warp. Completely self-contained, provides thermostatically-controlled temperatures to 38° F.



Water Economizers for . . .

Recirculation and cooling of process water where temperatures up to 85° F. are satisfactory.

Saves up to 95% of water cost.

Permits use of increased water volume.

For Complete Information Phone Mountain View 8-2860 or Write Dept. P.

MAYER REFRIGERATING ENGINEERS, INC.

Specialists In Industrial Process Cooling

LINCOLN PARK, NEW JERSEY

Directory Section

Index to directory 1018

Materials and chemicals 1024

Machinery 1041

Equipment 1050

Machine tools 1055

Supplies 1056

Specialized services 1059

Converters and processors (personnel and equipment) 1074

Custom molders and extruders 1074

Laminators 1090

Reinforced plastics processors 1094

Plastic sheet formers 1102

Vinyl film, sheeting, and coated fabric manufacturers 1106

Directory of trade designations of plastic materials and processes . 1108

Alphabetical list of manufacturers and addresses 1123

Index to advertisers 1150

INDEX TO DIRECTORY

The data herein are compiled from information furnished by the companies referred to and the publisher, its officers, employees and agents do not represent and or guarantee the accuracy of said data and listings and do not accept any responsibility in connection therewith. Said data, etc., are included as a service only. The symbol ★ before a company name indicates that the company is an advertiser in this issue. To find such advertising, refer to the "Index to Advertisers," p. 1150.

A

Abietates (plasticizers) 1036
Abrasion testing apparatus 1054
Abrasive belts, bands, specialties 1056
Abrasive forming 1061
Abrasive forming machines 1042
Abrasive materials 1061
Accelerated weathering testing apparatus 1054
Accumulators
  Air ballasted 1050
  Hydropneumatic 1050
  Weight 1050
Acids
  Mineral (chemicals) 1026
  Organic (chemicals) 1026
Acrylate and methacrylate
  Fabricators of 1065
  Molding compounds 1034
  Monomers 1035
  Resins 1036
  Rods and tubes 1038
  Sheets 1039
Acrylic (see acrylate, methacrylate)
Acrylic lacquer coatings 1027
Acrylic resins
  Adhesives 1024
  Emulsions and dispersions 1029
Adhesives 1024
Adipates (plasticizers) 1036
Agents
  Antistatic 1025
  Antitack 1025
  Emulsifying and dispersing 1029
  Mold release 1057
  Vulcanizing 1041
  Wetting 1041
Air ballasted accumulators 1050
Air compressors 1041
Air conditioning equipment 1050
Alcohols (chemicals) 1026
Alcohols (solvents) 1040
Aldehydes (chemicals) 1026
Alkalies (chemicals) 1026
Alkyd
  Lacquers (coatings) 1027
  Molding compounds 1034
  Resin adhesives 1024
  Resin emulsions and dispersions 1029
  Resins 1036
Allyl
  Alcohol (chemicals) 1026
  Monomers 1035
  Resin adhesives 1024
  Resin emulsions and dispersions 1029
  Resins 1036
  Rods and tubes 1038
  Sheets 1039
Alpha cellulose (fillers) 1031
Alpha methyl styrene monomers 1035
Amines (solvents) 1040
Aminos 1026
Ammonia (chemicals) 1026
Aniline-formaldehyde resins 1036
Animal (protein) adhesives 1024
Antistatic Agents 1025
Antitack Agents 1025
Apparatus, testing 1054
Applied decorations on plastics 1059
Arbor presses 1047
Asbestos (fabric, for laminating) 1031
Asbestos (fillers, mineral) 1031
Autoclaves 1050
Automatic thermosetting molding machines 1046

B

Bacteriostat 1025
Bags, multiwall paper 1056
Bags, vacuum and pressure 1056
Bags, rubber (mold makers, rubber) 1070
Ball bearings 1050
Ball mills 1046
Banbury mixers 1046
Band saw machines 1045
Bands, abrasives 1056
Barrels, tumbling 1050
Batchers (handling devices for sheet and film) 1052
Bearings 1050
Belts, abrasive 1056
Belts, stainless steel 1056
Bench grinders 1055
Bending machines (sheet plastic fabricating) 1049
Benzoyl peroxide (chemicals) 1026
Beryllium molds 1069
Beryllium for molds 1057
Beveling machines 1042
Biphenyls (plasticizers) 1036
Blades, saw 1058
Blanks, molding and laminating 1033
Blending machines 1042
Blow molding 1061
Blow molding machines 1042
Blowers, portable electric 1041
Boards, molding and laminating 1033
Board, particle 1058
Boilers 1050
Borers, jig (machines, drilling) 1055
Boring lathes 1055
Boring machines 1054
Boxes, corrugated and solid fibre 1056
Boxes, tote 1056
Branding equipment 1053
Broaching machines 1054
Buffing machines 1042
Buffing and polishing compounds 1056
Buffing and polishing wheels 1050
Butadiene-acrylonitrile (rubber, synthetic) 1039
Butadiene-styrene (rubber, synthetic) 1039
Butadiene monomers 1035

C

Caking presses 1047
Calendered vinyl film and sheeting 1106
Calendering
  Equipment 1050
  Machines 1042
  Rolls 1054
  Vinyl film and sheeting 1106
Camphor (chemicals) 1026
Camphor (plasticizers) 1036
Carbide tipped tools 1058
Carbon black (fillers) 1031
Cabron disulfide (chemicals) 1026
Casein 1025
  Adhesives, protein 1024
  Fabricators of 1065
  Rods and tubes 1038
  Sheets 1039
Cast phenolic
  Resins 1036
  Rods and tubes 1038
  Sheets 1039
Cast polyester resin
  Rods and tubes 1038
Cast resins, fabricators of 1065
  Sheets 1039
Cast vinyl film 1106
Casting (custom) 1061
Casting materials 1025
Catalysts (chemicals) 1026
Cellophane film 1032
Cellulose
  Derivatives (flake) 1026
  Lacquers (coatings) 1027
  Melt coatings 1027
Cellulose acetate
  Fabricators of 1065
  Film 1032
  Flake (cellulose derivatives) 1026
  Molding compounds 1034
  Rods and tubes 1038
  Sheets 1039
Cellulose acetate butyrate
  Fabricators of 1065
  Film 1032
  Flake (cellulose derivatives) 1026
  Molding compounds 1034
  Rods and tubes 1038
  Sheets 1039
Cellulose base
  Adhesives 1024
  Emulsions and dispersions 1029
  Expanded (foamed) plastics 1030
Cellulose derivatives (flake) 1026
Cellulose lacquers (coatings) 1027
Cellulose melt coatings 1027
Cellulose nitrate
  Fabricators of 1065
  Film 1032
  Flake (cellulose derivatives) 1026
  Rods and tubes 1038
  Sheets, rigid 1039
Cellulose Propionate
  Film 1032
  Flake (cellulose derivatives) 1026
  Molding compounds 1034
  Rods and tubes 1038
  Sheets, rigid 1039
Cellulose, regenerated (cellophane film) 1032
Cellulose Triacetate film 1032
Cellulose Triacetate sheet 1039
Cellulosic Coated Fabrics 1027
Cements (see adhesives)
Centerless grinders 1055
Centralized lubricating systems 1053
Chalk (fillers) 1031
Checkweighing scales 1054
Chemicals 1026
Chloroprene (rubber, synthetic) 1039
Chlorosulfonated polyethylene (rubber, synthetic) 1039
Chopped fabric (fillers) 1031
Chopping machines 1043
Chromium plating of molds 1071
Circular sawing machines 1045
Citrates (plasticizers) 1036
Clamps 1056
Cleaning compounds (mold) 1057
Coated fabrics 1027
Coated glass (glass, fibrous, coaters of) 1033
Coated paper, resin 1035
Coated yarns (see fibers, coated)
Coating, dip 1064
Coating equipment, high vacuum 1054
Coating machines 1042
Coating machines, wire 1046
Coatings 1027
Coconut shell flour (fillers) 1031
Cold molding compounds 1034
Cold molders 1074

Color dispersions in resins and plasticizers 1028
Colorants for dry coloring 1029
Components, molds (standard stock) 1053
Composite structures (foamed plastics)... 1030
Compounding machines 1042
Compounding rolls 1054
Compounding scales 1054
Compounding thermoplastics (see reclaiming of plastic scrap)
Compounds
  Buffing and polishing 1056
  Cleaning (mold) 1057
  Glycerol and glycol plasticizers 1036
  Halogenated (solvents) 1040
  Molding (exporters and importers) ... 1065
  Molding (manufacturers of) 1034
  Pipe joint 1058
  Purging 1058
  Sulfur (solvents) 1040
  Tumbling 1059
Compression molders 1074
Compression presses
  Automatic 1047
  Hand operated 1048
  Manual and semi-automatic 1047
Compressors, air 1041
Conditioning cabinets (testing apparatus). 1054
Consultants 1061
Contact resin laminators (see reinforced plastics processors)
Containers (see boxes and drums)
Continuous, presses 1047
Control valves, diaphragm 1059
Controllers
  Automatic film wind-up 1050
  Flow 1050
  Mold temperature 1046
  Pressure 1050
  Temperature 1050
  Time 1050
Converters and processors 1074
Conveyors 1050
Coolant pumps 1049
Cooling machines 1042
Cord (fillers) 1031
Cores for sandwich construction 1029
Corrugated boxes 1056
Cotton (fabrics) 1031
Cotton flock (fillers) 1031
Cottonseed hulls (fillers) 1031
Coumarone-indene
  Resin adhesives 1024
  Resin emulsions and dispersions 1029
  Resins 1036
Creasing machines, sheet plastic fabricating 1049
Cresol (chemicals) 1026
Cresylic acid (chemicals) 1026
  Custom Casting 1061
  Custom Extruders 1074
  Custom Molders 1074
  Custom Services 1059
Cut-off machines 1042
Cut-off wheels 1056
Cutters (cutting tools) 1055
Cutters, guillotine 1041
Cutters, Multi-layer Film 1042
Cutting machines 1042
Cutting of plastic film 1073
Cutting tools 1055
Cylinder liners (extruding machine) 1053
Cylinders, pneumatic, hydraulic and heating (for injection molding machines) ... 1051
Cylindrical bearings 1050

D

Dacron (Fabric, for laminating) 1031
Decalcomania 1056
Decorating machines 1044
Decorations, applied on plastics 1059
Decorative laminates (laminators) 1090
Deflashing machines 1042
Degating presses 1047
Densifying machines 1043
Deodorants 1029
Derivatives, cellulose 1026
Design plating on plastics 1062
Designers, industrial 1062
Detectors, metal 1046
Devices
  Fastening 1057
  Handling, for plastic sheet and film 1052
  Marking (equipment)... 1053
Dextrins (adhesives) 1024
Diallyl phthalate 1034
Diaphragm control valves 1059
Dicing machines 1043
Die cutting, plastic sheet stock 1063
Die sinking machines 1055
Die makers, extrusion 1064
Die makers, high freq. heat sealing 1064
Dies, Cutting 1051
Dies, steel rule clicker & dinker 1051
Dip coating, plastic 1064
Dipping machines 1043
Dispersing agents 1029
Dispersions 1029
Dispersions of color in resins and plasticizers 1028
Divinylbenzene monomers 1035
Drawing of thermoplastics 1102
Drawing machines (sheet plastic fabricating) 1049
Drill bench grinders 1055
Drill presses
  Multiple spindle 1054
  Single spindle 1054
Drilling machines 1054
Drive screws 1058
Drives, variable speed 1051
Drums, shipping 1056
Dry air blowers, portable electric 1041
Dry coloring
  Colorants for 1029
  Mixers 1046
Dry sanding machines 1045
Drying equipment 1051
Drying equipment infrared 1051
Duplicating machines 1054
Dust blowers, portable electric 1041
Dyeing plastics (applied decorations) 1059
Dyeing plastic materials and scrap (see Reclaiming of plastic scrap)
Dyes (see also pigments) 1029

E

Elastomers 1039
Electric
  Blowers, portable 1041
  Drying and preheating equipment 1051
  Motors 1053
  Press platens 1053
Electrical testing apparatus 1054
Electrodes, H. F. Heat Sealing 1056
Electroformed molds 1070
Electronic quilting 1064
Electronic tubes, high frequency 1059
Elevating tables 1054
Embedding 1064
Embossing
  Flexible film and sheeting 1064
  Machines (roll embossing) 1044
  Presses 1047
  Rigid plastic sheets 1064
  Rolls 1054
Emulsifying agents 1029
Emulsions 1029
Emulsions, water (latex, resin) 1033
Engraving
  Applied decorations 1059
  Equipment 1053
  Machines 1055
Epoxy adhesive resin 1024
Epoxy coatings 1027
Epoxy molding compounds 1034
Epoxy resins 1036
Equipment 1050
  Air conditioning 1050
  Calendering 1050
  Coating, high vacuum 1054
  Drying and preheating 1051
  Flame spraying 1051
  heating (for molds and molding machines) 1052
  High frequency preheating 1052
  High vacuum 1054
  Infrared drying and preheating 1051
  Marking 1053
  Rewinding 1053
  Welding 1054
Essence, pearl 1036
Esters (solvents) 1040
Etching (applied) decorations 1059
Ethers (solvents) 1040
Ethyl cellulose
  Fabricators of 1065
  Film 1032
  Flake (cellulose derivatives) 1026
  Molding compounds 1034
  Rods and tubes 1038
  Sheets 1039
Expanded (foamed) plastics 1030
Expanders (handling devices for plastic sheet and film) 1052
Exporters 1065
Extenders 1031
Extruders, custom 1074
Extruding machine cylinder liners 1053
Extruding machines 1043
Extrusion die makers 1064
Extruder screws 1058

F

Fabrics
  Fillers 1031
  Macerated or chopped (fillers) 1031
  Woven 1031
Fabricating machines (sheet plastic) 1049
Fabricators (all plastics) 1065
Fabricators (expanded plastics) 1067
Fabrics
  Asbestos (for laminating) 1031
  Coated 1027
  Cotton (for laminating) 1031
  Dacron (for laminating) 1031
  For laminating 1031
  Glass cloth and mat (for laminating).... 1031
  Glass fibers and fabric (filler)..... 1031
  Nylon (for laminating) 1031
  Orlon (for laminating) 1031
  Rayon (for laminating) 1031
  Woven (plastic)..... 1031
Fastening devices 1057
Fibers
  Glass (fibrous) 1033
  Synthetic 1031
Fibre boxes 1056
Fibre drums 1056
Fibre, vulcanized 1031
  Sheets, rods, tubes 1031
Fibrous glass, for reinforcement 1033
Fibrous glass preformers 1049
Filaments, synthetic 1031
Fillers 1031
Film
  Cutters, multi-layer 1042
  Flexible, metallizing of 1068
  Handling devices for 1052
  Heat sealing of 1067
  Plastic (sheeting and rolls) 1032, 1106
  Printing of 1072
Film & cloth cutting machines 1043
Film wind-up, controllers 1050
Filters 1051
Fittings, hydraulic 1059
Fittings, pneumatic 1059
Fixtures, spray painting 1058
Flake (cellulose derivatives) 1026
Flame spraying, plastic 1067
Flame spraying, plastic (equipment) 1051
Flexible-ball joints 1057
Flexible film and sheeting, embossing ... 1064
Flexible film, metallizing of 1068
Flexible materials for molds 1057
Flexible metal hose and tubing 1057
Flexographic Printing Presses 1048
Flock, cotton (fillers) 1031
Flocking (applied decorations) 1059
Flow controllers 1050
Flow meters 1051
Flow testing apparatus 1054
Fluorocarbon
  Fabricators 1065

Film ... 1032
Molding compounds ... 1034
Resins ... 1036
Resins emulsions and dispersions ... 1029
Rigid sheets ... 1039
Rods and tubes ... 1038
Foamed plastics (expanded plastics) ... 1030
Foaming machines ... 1043
Foil, stamping (roll leaf) ... 1058
Folding machines (sheet plastic fabricating) ... 1049
Formaldehyde (chemicals) ... 1026
Forming of thermoplastics ... 1102
Forming, vacuum machines ... 1045
Frazing machines ... 1043
Furan
Coatings ... 1027
Molding compounds ... 1034
Resin adhesives ... 1024
Resin emulsions and dispersions ... 1029
Resins ... 1036
Furans (solvents) ... 1040
Furfural (chemicals) ... 1026

G

Gages, plug and thread ... 1052
Gages, recording ... 1052
Gages, thickness ... 1052
Gas drying and preheating equipment ... 1051
Glass bonded mica (resin) ... 1036
Glass bonded mica (rods & tubes) ... 1038
Glass bonded mica (sheets) ... 1039
Glass, fibrous (for reinforcement) ... 1033
Glass, resin loaded for molding ... 1033
Gluing machines (sheet plastic fabricating) ... 1049
Glycerol (chemicals) ... 1026
Glycerol compounds (plasticizers) ... 1036
Glycol compounds (plasticizers) ... 1036
Glycolates (plasticizers) ... 1036
Glycols (chemicals) ... 1026
Glycols (solvents) ... 1040
Gold leaf stamping (applied decorations) ... 1059
Granulating machines ... 1043
Grinders
Bench, tap and drill ... 1055
Centerless ... 1055
Internal ... 1055
Portable hand ... 1055
Surface ... 1055
Tool ... 1055
Universal ... 1055
Grinding machines ... 1055
Grinding plastic materials and scrap (reclaiming) ... 1072
Guiders (handling devices for plastic sheets and film) ... 1052
Guillotine cutters ... 1041

H

Hack sawing machines ... 1045
Halogenated compounds (solvents) ... 1040
Halogenated derivatives
Molding compounds ... 1034
Rods and tubes ... 1038
Sheets ... 1039
Hand operated presses ... 1048
Handling devices for plastic sheets and film ... 1052
Handling equipment ... 1057
Hardness testing apparatus ... 1054
Heat distortion testing apparatus ... 1054
Heat sealing machines ... 1043
Heat sealing of film and sheet ... 1067
Heat transfer oil ... 1058
Heat treating of polyethylene for printing ... 1068
Heating equipment for molds and molding machines ... 1052
Hexamethylenetetramine (chemicals) ... 1026
High frequency
Electronic tubes ... 1059
Heat sealing die makers ... 1064
Preheating equipment ... 1052
Sealing machines ... 1043
High pressure laminators ... 1090
High tensile paper for resin impregnating ... 1035
High vacuum equipment ... 1054
Hinges, specialty metal ... 1057
Hobbing ... 1068
Hobbing presses ... 1048
Hobbs, material for ... 1057
Holding racks, vacuum plating ... 1054
Honeycomb, composite structures (expanded plastics) ... 1030
Honing machines (see liquid blasting machines)
Hose (flexible metal) ... 1057
Hot air drying and preheating equipment ... 1051
Hot stamping equipment (marking) ... 1053
Hot stamping press ... 1049
Hydraulic
Cylinders ... 1051
Fittings ... 1059
Oil ... 1058
Packing ... 1058
Power systems ... 1052
Power units ... 1047
Pumps ... 1049
Valves ... 1059
Hydrocarbon, petroleum (resin) ... 1036
Hydrocarbons (plasticizers) ... 1036
Hydrocarbons (solvents) ... 1040
Hydrocarbons, terpene (resin) ... 1036
Hydropneumatic accumulators ... 1050
Hydroxyethyl cellulose flake (cellulose derivatives) ... 1026

I

Impact testing apparatus ... 1054
Importers ... 1065
Impregnated glass (glass, fibrous) ... 1033
Impregnated paper, fabric and mat ... 1035
Impregnating machines ... 1044
Impregnating paper ... 1035
Impregnators of fibrous glass ... 1033
Industrial designers ... 1062
Industrial laminates (laminators) ... 1090
Infrared
Drying and preheating equipment ... 1051
Lamps ... 1057
Injection
Hand operated presses ... 1048
Molders, custom ... 1074
Molding machines ... 1044
Inks ... 1057
Inlaying, metal (applied decorations) ... 1059
Inorganic pigments ... 1036
Inserts ... 1057
Insulating varnishes ... 1041
Intensive internal mixers ... 1046
Internal grinders ... 1055
Ion exchange resins ... 1036
Isocyanates
Adhesives ... 1024
Chemicals ... 1026
Emulsions & dispersions ... 1029
Expanded (foamed) plastics ... 1030
Resins ... 1037
Synthetic rubber ... 1039

J

Jig borers (machines, drilling) ... 1055
Jig sawing machines ... 1045
Jobbers ... 1033
Joints ... 1057

K

Kellering (Custom) ... 1068
Kellering machines ... 1055
Ketones (solvents) ... 1040
Kettles, resin ... 1052
Kneading and mixing machines ... 1044

L

Labels, pressure sensitive ... 1057
Labeling machines ... 1044
Laboratories, testing ... 1073
Lacquer making resins ... 1037
Laminates ... 1033
Fabricators of ... 1065
Postforming of ... 1074
Reinforced ... 1094
Laminating
Blanks ... 1033
Boards ... 1033
Fabrics for ... 1031
Presses ... 1048
Resins, low pressure ... 1033
Resins, plywood ... 1037
Varnishes ... 1041
Laminators (see also reinforced plastics processors) ... 1090
Lamps, infrared ... 1057
Latex, resin ... 1033
Lathes (machines) ... 1055
Laurates (plasticizers) ... 1036
Leaf, roll (stamping foil) ... 1058
Levulinates (plasticizers) ... 1036
Lignin resins ... 1037
Lignite resins ... 1037
Liners, extruding machine cylinder ... 1053
Liquid blasting machines ... 1044
Low pressure laminating resins ... 1033
Lubricating systems, centralized ... 1053
Lubricants for molds (mold release agents) ... 1057
Luminescent pigments ... 1036
Luminescent plastics ... 1033

M

Macerated fabric (fillers) ... 1031
Machine screws ... 1058
Machine tools ... 1055
Machinery ... 1041
Machinery, exporters and importers ... 1065
Machines (see also presses)
Abrasive forming ... 1042
Automatic mask washing ... 1044
Automatic spray painting ... 1045
Automatic thermosetting molding ... 1046
Beveling ... 1042
Blending ... 1042
Blow molding ... 1042
Boring ... 1054
Broaching ... 1054
Buffing ... 1042
Calendering ... 1042
Coating ... 1042
Compounding ... 1042
Cooling ... 1042
Cut-off ... 1042
Cutting & slitting, fibrous glass ... 1042
Decorating and labeling ... 1044
Deflashing ... 1043
Densifying ... 1043
Dicing, chopping and cutting ... 1043
Die sinking ... 1054
Dipping ... 1043
Drilling ... 1054
Duplicating ... 1054
Engraving ... 1054
Extruding ... 1043
Film & cloth cutting ... 1043
Foaming ... 1043
Frazing ... 1043
Granulating ... 1043
Grinding ... 1055
Heat sealing ... 1043
Impregnating ... 1044
Injection molding ... 1044
Kellering ... 1055
Kneading and mixing ... 1044
Labeling and decorating ... 1044
Lathes ... 1055
Liquid blasting ... 1044
Mangling ... 1055
Metal spraying ... 1044
Milling ... 1055
Mixing and kneading ... 1044
Moisture and volatile extraction ... 1044
Paint wiping ... 1044
Planing ... 1055
Polishing ... 1044
Profiling ... 1055
Pulverizing ... 1044
Rebuilt ... 1049
Roll embossing ... 1044
Roller coating ... 1045
Rotary finishing ... 1045
Rotational molding machines ... 1046
Routing ... 1055
Sanding (wet and dry) ... 1045
Sawing ... 1045

Screening, separating and sifting 1045
Shaping 1055
Sheet forming 1045
Sheet plastic fabricating 1049
Slitting 1045
Slitting and mangling 1045
Slush molding 1046
Spooling, for extrusions 1045
Spray mask painting 1045
Spray mask washing (automatic) 1045
Spray painting (automatic) 1045
Tapping 1046
Tube rolling 1046
Tumbling 1046
Turning (lathes) 1055
Used and rebuilt 1049
Wire coating 1046
Maleic acid (chemicals) 1026
Mangling and slitting machines 1045
Manual compression presses 1047
Manufacturers
Casting materials 1025
Glass, fibrous (for reinforcements) 1033
Molding compounds 1034
Vinyl film, sheeting, coated fabric 1106
Marking equipment 1053
Marking (applied decorations) 1059
Mask washing machines, automatic 1044
Masking paper and tape 1057
Masks, spray 1073
Materials and chemicals 1024
Materials, abrasive 1056
Materials for flexible molds 1057
Materials for hobs and molds 1057
Materials, mold making 1057
Melamine
Chemicals 1026
Coatings 1027
Resins adhesives 1024
Resins emulsions and dispersions 1029
Melamine-formaldehyde
Molding compounds 1034
Resins 1037
Metal detectors, electronic 1046
Metal drums 1056
Metal hose and tubing, flexible 1057
Metal inlaying 1059
Metal-metal spraying machines 1044
Metal specialty hinges 1057
Metallic pigments 1036
Metallizing of plastics
Finished products 1068
Flexible film 1068
Rigid sheet 1068
Metallic fillers 1031
Metering systems 1053
Meters, flow 1051
Methacrylate
Fabricators of 1065
Molding compounds 1034
Monomers 1035
Resins 1036
Rods and tubes 1038
Sheets 1039
Methyl cellulose flake 1026
Mica (fillers, mineral) 1031
Mica, glass bonded (resin) 1036
Mica, glass bonded (rods & tubes) 1038
Mica, glass bonded (sheets) 1039
Millers (cutting tools) 1054
Milling machines 1055
Milling plastic materials and scrap, custom (see reclaiming)
Mills, ball or pebble 1046
Mills, roll 1046
Mineral acids (chemical) 1026
Mineral fillers 1031
Mixers, banbury 1046
Mixers, dry coloring & blending 1046
Mixers, intensive internal 1046
Mixing and kneading machines 1044
Model makers 1068
Moisture extraction machines 1044
Mold and hob steel 1057
Mold cavities, hobbed steel (hobbing) 1068
Mold components (standard stock) 1053
Mold heating equipment 1052
Mold lubricants (mold release agents) 1057
Mold makers, aluminum 1069
Mold makers, beryllium 1069
Mold makers, electroforming 1070
Mold makers, extrusion (see die makers, extrusion)
Mold makers, ferrous metals 1069
Mold makers, metal spraying 1070
Mold makers, plastics 1069
Mold makers, reinforced plastics 1070
Mold makers, rubber 1070
Mold makers, steel 1070
Mold polishing 1071
Mold release agents 1057
Mold temperature controllers 1046
Molded laminate 1090, 1094
Molders
Cold 1074
Custom 1074
Low pressure (see reinforced) 1090
Reinforced plastics 1094
Molding boards and blanks 1033
Molding compounds
Exporters and importers of 1065
Manufacturers of 1034
Molding machine heating equipment 1052
Molding machines (see also presses)
Automatic thermosetting 1046
Heating equipment for 1052
Injection 1044
Molding presses
Compression 1047
Transfer 1049
Molding, resin loaded glass 1033
Molding, resin pulp and fiber 1073
Molding, slush 1073
Molds (mold makers) 1069
Molds, flexible materials for 1055
Molds, heating equipment for 1052
Molds, plating of 1071
Molds, rubber 1070
Molds, steel for 1057
Monofilaments (see fibers and filaments, synthetic)
Monomers 1035
Motors 1053
Multidirectional stretched film 1032
Multiple spindle drill presses 1054

N

Natural resins (see adhesives and molding compounds)
Natural rubber base coatings 1027
Needle bearings 1050
Nickel plating of molds 1071
Nitriles (solvents) 1040
Nitrohydrocarbon (solvents) 1040
Nozzles (for injection machines) 1053
Nylon
Adhesives 1024
Fabricators of 1065
Fabrics (for laminating) 1031
Film 1032
Molding compounds 1034
Resins 1037
Rods and tubes 1038
Sheets 1039

O

Oil base coatings 1027
Oil, heat transfer and hydraulic 1058
Oil purifiers 1051
Oil soluble resins 1037
Oleates (plasticizers) 1036
Organic acids (chemicals) 1026
Organosols and plastisols 1035
Orlon (fabrics, for laminating) 1031
Ovens (see drying and preheating equipment) 1053
Ovens, testing apparatus 1054

P

Packaging, partition 1058
Packing, hydraulic 1058
Paint wiping machines 1044
Paints, wipe-in 1059
Panel sawing machines 1045
Paper
For resin impregnating 1035
Masking 1057
Paper, release 1058
Printed, for laminating 1035
Resin coated 1035
Resin impregnated 1035
Paraformaldehyde (chemicals) 1026
Particle board 1058
Partitions, packaging 1058
Pearl essence 1036
Pebble mills 1046
Pegs, tumbling 1058
Pentaerythritol (chemicals) 1026
Perforating of plastic sheeting 1071
Peroxides (chemicals) 1026
Personnel and equipment
Cold molders 1074
Custom casting 1061
Custom molders and extruders 1074
Fabricators 1065
Fabricators, laminates and vulcanized fibre 1065
Laminators 1090
Plastic sheet processors 1102
Reinforced plastics processors 1094
Resin pulp and fibre processors 1073
Vinyl film, sheeting, and coated fabric manufacturers 1106
Phenol (chemicals) 1026
Phenolic
Cast resins 1036
Cast rods and tubes 1038
Cast sheets 1039
Coatings 1027
Expanded foamed plastics 1030
Molding compounds 1034
Resin adhesives 1024
Resin emulsions and dispersions 1029
Resins 1037
Phosphates (plasticizers) 1036
Photoelastic plastics 1036
Phthalates (plasticizers) 1036
Phthalic Anhydride (chemicals) 1026
Pigments, inorganic 1036
Pigments, luminescent 1036
Pigments, metallic 1036
Pipe joint compounds 1058
Pipe joints 1057
Pitches and tar bases 1036
Plain milling machines 1055
Planing machines 1055
Plants, resin manufacturing 1049
Plastic
Boards and blanks 1033
Dip coating 1064
Fabrics (for laminating) 1031
Fabrics, woven 1031
Film 1032, 1106
Film and sheets, embossing of 1064
Film and sheets, heat sealing of 1067
Film and sheets, metallizing of 1068
Film, slitting, cutting, sheeting of 1073
Flame spraying 1067
Flame spraying equipment 1051
Materials, reclaimers 1072
Rubberlike (Elastomers) 1039
Sheet and film, handling devices 1052
Sheet fabricating machines 1049
Sheet formers (forming & drawing of thermoplastics) 1102
Sheet stock die cutting 1063
Sheeting, perforating of 1071
Welding equipment 1054
Plasticizers 1036
Plastics
Applied decorations on 1059
Expanded 1030
Fibrous 1033
Inks for printing 1057

Labels for ... 1057
Luminescent ... 1033
Metallizing, flexible film ... 1068
Photoelastic ... 1036
Reinforced, processors of ... 1094
Plastisols ... 1035
Platens, press ... 1053
Plates for compression molding ... 1053
Plates, plating of ... 1071
Plates, press polishing ... 1053
Plating of molds, rams and plates ... 1071
Plug gages ... 1052
Plywood
Bonding and laminating resins ... 1037
Laminators ... 1090
Molders ... 1074
Pneumatic cylinders ... 1051
Pneumatic fittings ... 1058
Polishing
Compounds ... 1056
Machines ... 1044
Mold ... 1071
Plates, press ... 1053
Wheels ... 1050
Polyamide (nylon) (see also nylon)
Coatings ... 1027
Resin Adhesives ... 1024
Resin emulsions and dispersions ... 1029
Molding compounds ... 1034
Resins ... 1037
Polyester
Cast rods and tubes ... 1038
Cast sheets ... 1039
Plasticizers ... 1036
Resin adhesives ... 1024
Resin emulsions and dispersions ... 1029
Resins ... 1037
Polyethylene
Chlorosulfonated (rubber synthetic) ... 1039
Fabricators of ... 1065
Film ... 1032
Molding compounds ... 1034
Resins, also (low molecular) ... 1037
Rods and tubes ... 1038
Sheets ... 1039
Polyethylene treaters for printing ... 1047
Polyisobutylene (rubber, synthetic) ... 1039
Polystyrene (see also styrene)
Fabricators of ... 1065
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Polysulfide (rubber, synthetic) ... 1039
Polytetrofluoroethylene (see tetrafluoroethylene)
Polyvinyl acetate film ... 1032
Polyvinyl alcohol
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Polyvinyl butyral
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Polyvinyl chloride
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Polyvinyl chloride acetate
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Polyvinyl chloride-vinylidene chloride film 1032
Polyvinyl formal
Rods and tubes ... 1038
Sheets ... 1039
Polyvinylidene chloride
Film ... 1032
Rods and tubes ... 1038
Sheets ... 1039
Portable
Electric blowers ... 1041
Hand grinders ... 1055
Postforming (of laminates) ... 1071
Postforming, laminates for ... 1033
Power systems, hydraulic ... 1052
Power units, hydraulic ... 1047
Preformers, fibrous glass ... 1033
Preforming presses ... 1049
Preforming resin pulp and fibre ... 1074
Preheating equipment
Electric, gas, hot air, steam ... 1051
High frequency ... 1052
Infrared ... 1051
Premix-Glass Polyester molding compounds 1034
Press platens ... 1053
Press polishing plates ... 1053
Presses (see also machines)
Arbor ... 1047
Caking ... 1047
Compression, automatic ... 1047
Compression, manual and semi-automatic 1047
Continuous ... 1047
Degating ... 1047
Drill, multiple spindle (machines, drilling 1054
Drill, single spindle (machines, drilling). 1054
Embossing ... 1047
Flexographic printing presses ... 1048
Hand operated, compression ... 1048
Hand operated, injection ... 1048
Hobbing ... 1048
Hot stamping and roll leaf ... 1049
Injection (machines, injection) ... 1044
Laminating ... 1048
Plastic printing ... 1049
Preforming ... 1049
Roll leaf and hot stamping ... 1049
Transfer molding ... 1049
Pressure cast beryllium molds ... 1069
Pressure controllers ... 1050
Pressure sensitive labels ... 1057
Printing
Equipment (marking equipment) ... 1053
Finished plastic products ... 1072
Flexible film and sheeting ... 1072
Inks ... 1057
Presses, plastic ... 1047
Rigid plastic sheets ... 1072
Rolls ... 1054
Processors and converters ... 1074
Profiling machines ... 1055
Proportioning Systems ... 1053
Proportioning temperature controllers ... 1050
Protein base adhesives ... 1024
Protein base emulsions, dispersions ... 1029
Pulverizing (custom) ... 1072
Pulverizing machines ... 1044
Pumps
Coolant ... 1049
Hydraulic ... 1049
Vacuum ... 1049
Purging compounds ... 1058
Purifiers, oil ... 1051
Pyrometers ... 1053
Pyroxylin (see cellulose nitrate)

R

Radial bearings ... 1050
Radial sawing machines ... 1045
Rams, plating of ... 1071
Rayon (fabrics) ... 1031
Rebuilt machines ... 1049
Reclaimers, plastic materials ... 1072
Recording gages ... 1052
Regenerated cellulose (film) ... 1032
Reground materials (see scrap dealers, and reclaiming of plastic scrap)
Regulators, mold temperature ... 1046
Reinforced plastics processors ... 1094
Release agents for molds ... 1057
Release papers ... 1058
Reprocessing scrap (reclaiming) ... 1079
Resin base emulsions and dispersions ... 1029
Resin coated paper ... 1035
Resin emulsions (latex, resins) ... 1033
Resin, loaded glass for molding ... 1033
Resin impregnated paper ... 1035
Resin impregnating paper ... 1035
Resin kettles ... 1052
Resin latex ... 1033
Resin manufacturing plants ... 1049
Resin pulp and fibre processors ... 1073
Resins ... 1036
Resins and plasticizers, color dispersions in ... 1028
Resins, exporters and importers of ... 1065
Resins, low pressure laminating ... 1033
Resorcinol
Chemicals ... 1026
Resin adhesives ... 1024
Resins emulsions and dispersions ... 1029
Resorcinol-aldehyde resins ... 1037
Revolving joints ... 1057
Rewinding equipment ... 1053
Ricinoleates (plasticizers) ... 1036
Rigid sheets ... 1039
Rigid sheets, embossing of ... 1064
Rods
Extruders of ... 1074
Fibre, vulcanized ... 1031
Manufacturers of, with some stock ... 1038
Roll embossing machines ... 1044
Roll leaf (stamping foil) ... 1058
Roll leaf stamping equipment (marking equipment) ... 1053
Roll leaf stamping presses ... 1049
Roll mills ... 1046
Roller bearings ... 1050
Roller coating machines ... 1045
Rollers for roller coating ... 1058
Rolls
Calendering and compounding ... 1054
Embossing ... 1054
Printing ... 1054
Rotary finishing machines ... 1045
Rotary head milling machines ... 1025
Rotational molding machines ... 1046
Routers (cutting tools) ... 1054
Routing machines ... 1055
Rubber base
Adhesives ... 1024
Coatings ... 1027
Emulsions and dispersions ... 1029
Expanded (foamed) plastics ... 1030
Rubber molds (mold makers, rubber) ... 1070
Rubber coated fabrics ... 1027
Rubber, synthetic ... 1039
Rubberlike plastics (Elastomers) ... 1039

S

Sanding machines (wet and dry) ... 1045
Saw blades ... 1058
Sawing machines ... 1045
Scales ... 1054
Screening, separating and sifting machines 1045
Screws ... 1058
Screws, Extruder ... 1058
Sealing machines, heat ... 1043
Sealing of film & sheet (heat sealing) ... 1067
Sebacates (plasticizers) ... 1036
Secondary plasticizers ... 1036
Self-adhesive labels ... 1057
Semi-automatic compression presses ... 1047
Separating, screening and sifting machines 1045
Shaping machines ... 1055
Shears, squaring ... 1054
Sheet, handling devices for ... 1052
Sheet, plastic fabricating machines ... 1049
Sheet formers, fabricators ... 1065
Sheet stock, die cutting of ... 1063
Sheet stock, embossing of ... 1064
Sheeters (handling devices for sheet) ... 1052
Sheeting (film) ... 1032, 1106
Sheeting of plastic film ... 1073
Sheets
Fibre, vulcanized ... 1031
Rigid ... 1039

Adhesives (miscellaneous) 1024
Molding compounds 1034
Shipping containers (see boxes and drums)
Sifting machines 1045
Sifting, screening and separating machines 1045
Silica (fillers, mineral) 1031
Silicate adhesives 1024
Silicone
Adhesives 1024
Coatings 1027
Fabricators of 1065
Molding compounds 1034
Resins 1037
Rods and tubes 1038
Rubber, synthetic 1039
Sheets 1039
Silk screening (applied decorations) 1059
Silk screen makers 1073
Single spindle drill presses 1054
Sisal
Fillers 1031
Slitting and mangling machines 1045
Slitting of plastic film 1073
Slush molding 1072
Slush molding machines 1046
Sodium carboxymethyl cellulose film 1032
Sodium carboxymethyl cellulose flake 1026
Sodium carboxymethyl cellulose resin 1037
Solid fibre boxes 1056
Solvents 1040
Soybean (protein) adhesives 1024
Specialized services 1059
Specialties, abrasive 1056
Specialty metal hinges 1057
Spooling machines (for extrusions) 1045
Spray mask painting machines 1045
Spray masks 1073
Spray painting fixtures 1058
Spray painting machines, automatic 1045
Spraying (applied decorations) 1059
Spraying, flame 1067
Spraying metal, machines 1044
Squaring shears 1054
Stabilizers 1041
Stainless steel belts 1056
Stamping foil (roll leaf) 1056
Stamping (marking) equipment 1053
Stamping presses 1058
Starch (adhesives) 1024
Static eliminators 1054
Steam drying, preheating equipment 1051
Steam press platens 1053
Steam traps 1054
Stearates
Chemicals 1026
Plasticizers 1036
Steel for hobs and molds 1057
Steel mold cavities, hobbed (hobbing) 1068
Steel rule dies clicker and dinker 1051
Straighteners (handling devices) 1052
Strength testing apparatus 1054
Styrene (also see polystyrene)
Expanded (foamed) plastics 1030
Molding compounds 1034
Monomers 1035
Resin adhesives 1024
Resin emulsions and dispersions 1029
Resins 1037
Styrene copolymers
Fabricators of 1065
Molding compounds 1034
Resins 1037
Rods and tubes 1038
Sheets 1039
Styrene derivatives, resins 1037
Succinates (plasticizers) 1036
Sulfonamide (plasticizers) 1036
Sulfur compounds (solvents) 1040
Supplies 1056
Supported film and sheeting 1106
Surface grinders 1055
Swivel joints 1057
Synthetic fibers and filaments 1031
Synthetic resin adhesives 1024
Synthetic rubber 1039
Base coatings 1027
Plasticizers 1036
Systems, hydraulic power 1052
Systems, lubricating (centralized) 1053
Systems, proportioning 1053

T

Tables, elevating 1054
Tap bench grinders 1055
Tape, masking 1057
Taper bearings 1050
Tapping machines 1046
Taps 1058
Temperature controllers mold 1046
Tension fastening devices 1057
Testing apparatus
Abrasion 1054
Accelerated weathering 1054
Conditioning cabinets 1054
Electrical 1054
Flow 1054
Hardness 1054
Heat distortion 1054
Impact 1054
Ovens 1054
Strength 1054
Visual color matching 1054
Miscellaneous 1054
Testing laboratories 1073
Thermal sealing machines 1043
Thermoplastic casting plastics 1025
Thermoplastic laminators 1090
Thermoplastics
Sheet forming and drawing of 1102
Thermosetting automatic molding machines 1046
Thermosetting casting plastics 1025
Thickness gages 1052
Thread cutting screws 1058
Thread forming screws 1058
Thread gages 1052
Threads (see fibers, synthetic)
Thrust bearings 1050
Time controllers 1050
Toluenesulfonates (plasticizers) 1036
Tool grinders 1055
Tools and dies (see die makers and mold makers)
Tools
Carbide tipped 1058
Cutting 1054
Machine 1055
Tote boxes 1056
Transfer molders 1072
Transfer molding presses 1049
Traps, steam 1054
Tube rolling machines 1046
Tubes
Extruders of 1072
Fibre, vulcanized 1031
H. F. electronic 1058
Manufacturers of, with some stock 1038
Tubing, flexible metal 1057
Tumbling barrels 1050
Tumbling compounds 1058
Tumbling machines 1046
Tumbling pegs 1058
Tungsten 1059
Turning lathes 1055

U

Universal grinders 1055
Universal milling machines 1055
Urea
Chemicals 1026
Coatings 1027
Expanded foamed plastics 1030
Resin adhesives 1024
Urea-formaldehyde
Molding compounds 1034
Resins 1037
Used machines 1049

V

Vacuum equipment, high 1054
Vacuum forming 1102
Vacuum forming machines 1045
Vacuum plating holding racks 1054
Vacuum pumps 1049
Valves, diaphragm control 1059
Valves, hydraulic 1059
Valves, pneumatic 1059
Variable speed drives 1051
Varnish making resins 1037
Varnishes 1041
Vertical milling machines 1055
Vibrators 1054
Vinyl acetal molding compounds 1034
Vinyl acetate
Molding compounds 1034
Monomers 1035
Resins 1037
Vinyl alcohol
Molding compounds 1034
Resins 1037
Vinyl butyral resins 1037
Vinyl carbazole
Monomers 1035
Resins 1037
Vinyl chloride
Molding compounds 1034
Monomers 1035
Resins 1037
Vinyl chloride acetate
Molding compounds 1034
Resins 1037
Vinyl chloride-vinylidene chloride
Molding compounds 1034
Resins 1037
Vinyl coated fabric 1027
Vinyl coatings 1027
Vinyl ethers (monomers) 1035
Vinyl, fabricators of 1065
Vinyl film, sheeting, coated fabric manufacturers 1106
Vinyl formal
Molding compounds 1034
Resins 1037
Vinyl resin adhesives 1024
Vinyl resin emulsions and dispersions 1029
Vinyl resin expanded foamed plastics 1029
Vinyl sheeting 1106
Vinylidene chloride
Molding compounds 1034
Monomers 1035
Resins 1037
Visual color matching testing apparatus .. 1054
Volatile extraction machines 1044
Vulcanized fibre 1031
Vulcanizing agents 1041

W

Walnut shell flour (fillers) 1031
Water emulsions (latex, resin) 1033
Water soluble resins 1037
Weavers of glass (glass, fibrous) 1033
Weigh-feeders 1054
Weighing scales 1054
Weight accumulators 1050
Welding equipment 1054
Wet sanding machines 1045
Wetting agents 1041
Wheels, buffing and polishing 1050
Wheels, cut-off 1056
Winding equipment (rewinding) 1053
Wipe-in paints (stick form) 1059
Wire-coating machines 1046
Woodflour fillers 1031
Woven fabrics (plastic) 1031

X

Xylenol (chemicals) 1026

MATERIALS AND CHEMICALS

ADHESIVES

For related editorial information see Adhesives Chart, P. 564

A. *Casein*
B. *Cellulose Base*
C. *Protein Base (Animal, Casein, Soybean, Etc.)*
D. *Rubber Base*
E. *Silicate*
F. *Starch and Dextrins*
Synthetic Resins
G. *Acrylic Resins*
H. *Allyl Resins*
I. *Coumarone-Indene*
J. *Epoxy Resins*
K. *Furan Resins*
L. *Isocyanate Resins*
M. *Melamine Resins*
N. *Nylon (Polyamide)*
O. *Phenolic (Resins)*
P. *Polyesters (Alkyds)*
Q. *Resorcinol Resins*
R. *Silicone Resins*
S. *Styrene Resins*
T. *Urea Resins*
U. *Vinyl Resins*

Acco Polymers, New York (*G*)
● **Acme Resin Corporation**, Forest Park, Ill. (*H, O*)
Adhesive Products Corporation, New York (*A, B, D, F, G, H, I*)
Adhesive Products, Inc., Albany, Calif. (*A, B, C, D, F, G, H, I, U*)
Alkydol Laboratories, Inc., Cicero, Ill. (*J, O, P, U*)
● **American Cyanamid Co., Plastic & Resin Div.**, New York (*M, P, T*)
● **American Cyanamid Co.**, New York (*H, M, T*)
American Hard Rubber Co., New York (*D*)
American-Marietta Co., Adhesive, Resin, Chemical Div., Seattle, Wash. (*A, C, F, O, Q, T*)
● **Angier Adhesives, Div. of Interchemical**, Cambridge, Mass. (*D, J, L, O, S, U*)
● **Anorgana G. M. B. H.**, New York (*U*)
Applied Plastics, Co., Inc., El Segundo, Calif., (*J, L*)
Arabol Mfg. Co., New York (*A, C, D, E, F, U*)
● **Archer-Daniels-Midland Co., Chem. Products Div.**, Cleveland, Ohio (*A, C, F, P*)
Aries, R. S. & Associates, New York (*J*)
Aries Laboratories, Inc., Long Island City, N.Y. (*J*)
Armstrong Products Co., Warsaw, Ind. (*J*)
Atlas Mineral Products Co., Mertztown, Pa. (*E, J, K, L, O, P*)
Atlas Powder Co., Wilmington, Del. (*P*)
B. B. Chemical Co., Cambridge, Mass. (*A, D, F, I, J, L, N, O, Q, S, U*)
B. I. P. Chemicals Limited, Nr. Birmingham, England (*P, T*)
BX Plastics Ltd., London, England (*A, B, D, S*)
● **Badische Anilin & Soda Fabrik A. G.** Ludroigshafer Rhein, Germany (*G, N, P, S, T, U*)
● **Bakelite Co., A Div. of Union Carbide Corp.**, New York (*J, O, P, Q, R, S, U*)
● **Barrett Div., Allied Chemical & Dye Corp.**, New York (*I, O, P, T*)
Barrett Varnish Co., Cicero, Ill. (*B, G*)
● **Belding Corticelli Industries**, New York (*N*)
Biggs, Carl H. Co., Inc., Los Angeles, (*J*)
Blacher, B., New York (*U*)
Borden Co., Chemical Div., New York (*A, C, D, G, J, O, Q, T, U*)
● **Cadillac Plastic & Chemical Co.**, Detroit, (*G, U*)
California Ink Co., Inc., San Francisco, (*D*)
● **Celanese Corporation of America**, Newark, N.J. (*P*)
Chemical Development Corp., Danvers, Mass. (*B, C, F, G, J, L, O, R, S, U*)
● **Chemical Products Corp.**, East Providence, R.I. (*G, J, L, S, U*)
Chemtron Fiber Glass Co., El Monte, Calif. (*J*)
● **Claremont Pigment Dispersion Corp.**, Roslyn Hgts., New York (*U*)
Compo Chemical Co., Mansfield, Mass. (*B, D, G, I, J, L, M, O, P, Q, S, U*)
● **Cordo Chemical Corp.**, Norwalk, Conn. (*J, P, U*)
● **Diamond Alkali Co.**, Chlorowax Div., Cleveland, (*E*)
Dennis Chemical Co., St. Louis, Mo. (*B, D, J, U*)
● **Dewey & Almy Chemical Co., Div. of W. R. Grace & Co.**, Cambridge, Mass. (*D*)
Dow Corning Corp., Midland, Mich. (*D, R*)
Dreyfus L. A. Co., Inc., South Plainfield, N.J. (*D*)
● **du Pont, E. I. de Nemours & Co., Inc.**, Wilmington, Del. (*B*)
● **Durez Plastics Div., Hooker Electrochemical Co.**, North Tonawanda, N.Y. (*K, O*)
● **Eastman Chemical Products, Inc.**, Kingsport, Tenn. (*B*)
Elastomer Chemical Corp., Newark, N.J. (*U*)
Electro-Chemical Products Corp., Cleveland (*U*)
Emerson & Cuming, Inc., Canton, Mass. (*J*)
Epoxylite, The, Corp., El Monte, Calif. (*J*)
Farrington Texol Corp., Walpole, Mass. (*B, D, G, S, U*)
Federal Chemicals Corp., Brooklyn, N.Y. (*A, D, F, G*)
Federal Latex Corp., Brooklyn, N.Y. (*D, G, Q, S*)
Flexcraft Industries, Newark, N.J. (*B, D, F, G*)
Flexible Products, Co., Marietta, Ga. (*U*)
Fuller, H. B., Co., St. Paul, Minn. (*C, D, E, F, J, U*)
● **Furane Plastics Inc.**, Los Angeles (*J, K, L*)
Garan Chemical Corp., Gardena, Calif. (*J, P, U*)
Garlock Packing Co., Palmyra, N.Y. (*J*)
General Dispersions Inc., Paterson, N.J. (*N*)
● **General Electric Company, Chemical & Materials Dept.**, Pittsfield, Mass. (*O*)
General Mills, Inc., Kankakee, Ill., (*N*)
● **General Tire & Rubber Co., Chemical Div.**, Akron, Ohio (*D*)
● **Goodrich Chemical Co., B. F.**, Cleveland, Ohio (*U*)
● **Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co.**, Akron, Ohio (*D*)
● **Goodyear Tire & Rubber Co., The, Chemical Div.**, Akron, Ohio (*D*)
Greeff, R. W., & Co., Inc., New York (*T*)
Greene Plastics Corp., Hope Valley, R.I. (*U*)
● **Hardman, H. V. Co.**, Belleville, N.J. (*J, O*)
Haveg Industries, Inc., Wilmington, Del. (*K, O*)
Haynes, C. W. Laboratories, Inc., Springfield, Mass. (*B, F*)
Heresite & Chemical Co., Manitowoc, Wis. (*O*)
Hewitt, C. B. & Bros., Inc., New York (*A, T, U*)
Homalite Co., The, Wilmington, Del. (*J, P*)
● **Hommel, O. Co., The**, Pittsburgh, Pa. (*E, F*)
Houghton Laboratories, Inc., Olean, New York (*J*)
● **Imperial Chemical Industries Ltd., Plastics Div.**, Hertfordshire, Eng. (*G, N, O, T, U*)
Industrial Latex Co., Wallington, N.J. (*A, C, D, F, J, O, U*)
● **Industrial Solvents & Chemicals, Inc.**, Wilkinsonville, Mass. (*G*)
Ironsides Resins, Inc., Columbus, Ohio (*K, O*)
Johns-Manville, New York (*D*)
● **Koppers Co., Inc.**, Pittsburgh, Pa. (*Q, S*)
● **Krieger Color & Chemical Co., Inc.**, Los Angeles, Calif. (*G, S*)
Lami-Plast Products Co., Tampa, Florida (*J*)
Lawrence Adhesive & Chemical Co., Inc., Lawrence, Mass. (*D, J*)
Lithgow Chemicals Co., Division of Reinhold Engineering & Plastics Company, Norwalk, Calif. (*J, K, N, S, U*)
Magic Chemical Co., Brockton, Mass. (*A, B, C, D, F, G, H, J, K, L, M, N, O, P, Q, R, S, T, U*)
● **Marblette Corp., The, L. I. C.**, N.Y. (*J, M*)
● **Marbon Chemical Div., Borg-Warner Corp.**, Gary, Ind. (*D, F*)
Midland Adhesive & Chemical Corp. Ferndale, Mich. (*A, B, C, D, E, F, G, O, P, S, T, U, J*)
Minnesota Mining & Mfg. Co., St. Paul, Minn. (*D, E, G, O, U, J, L*)
Miracle Adhesive Corporation, Bellmore, L.I., N.Y. (*B, D, G, I, J, N, O, P, Q, S, U*)
Mobay Chemical Co., St. Louis, Mo. (*L*)
Monite Waterproof Glue Co., Minneapolis, Minn. (*A, C, F, T, U*)

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

● Monsanto Chemical Co. Springfield, Mass. (*A, C, M, O, Q, T*)
Morton Withers Chemical Co. Greensboro, N.C. (*L*)
National Adhesives Div., National Products Inc., New York (*A, B, C, D, F, U, J*)
National Casein Co., Chicago (*A, C, D, O, Q, T, U*)
● Naugatuck Chemical, Naugatuck, Conn. (*D, S, U*)
● Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*D, P*)
Navarm Chemical Co., Maywood, Calif. (*D*)
Neville Chemical Co., Pittsburgh (*I*)
Ohio Adhesives Corp., New Phila., Ohio (*B, D, G, I, J, N, O, P, Q, S, U*)
Paisley Products Inc., New York (*A, C, D, E, F, Q, T, U, J*)
Pelron Corporation, Lyons, Ill. (*L*)
Perkins Glue Co., Lansdale, Pa. (*A, C, F, O, Q, T*)
● Peters Chemical Mfg. Co., Melrose Park, Ill. (*G*)
Philadelphia Quartz Company, Philadelphia, Pa. (*E*)
Pierce & Stevens Chem. Corp., Buffalo, N.Y. (*B, D, G, I, P, U, J, L*)
● Pittsburgh Plate Glass Co., Pittsburgh, Pa. (*P*)
Plastic Center, Rochester, N.Y. (*G, S*)
● Plastics Engineering Co., Sheboygan, Wis. (*O*)
Poly Resins, Sun Valley, Calif. (*J, O, U*)
Polymer Chemical Co., Cincinnati, Ohio (*A, B, C, D, G, I, Q, S, T, U*)
● Polymer Corporation, Reading, Penn. (*N*)
Polymer Industries Inc., Springdale, Conn. (*A, B, C, D, F, J, U*)
● Polypenco, Inc., Reading, Penn. (*N*)
Protective Treatments, Inc., Dayton, Ohio (*U*)
Pyroxylin Products, Inc., Chicago, Ill. (*B, D, G, I, U*)
Raffi and Swanson, Inc., Wilmington, Mass. (*B, S, U*)
Randolph Products Co., Carlstadt, N.J. (*B, D, G,*)
● Reichhold Chemicals, Inc., White Plains, N.Y. (*A, C, J, M, O, P, Q, T, U*)
Reliance Plastic & Chemical Corp., Paterson, N. J. (*B, G, S, U*)
Ren Plastics Inc., Lansing, Mich. (*J*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*U*)
● Reynolds Chemical Products Co., Ann Arbor, Mich, (*J. L, U*)
Rezolin, Inc., Santa Monica, Calif. (*J*)
H. H. Robertson Co., Pittsburgh (*P, J*)
● Rohm & Haas Co., Philadelphia, Pa., (*G, I, O, P, Q*)
● Rubber & Asbestos Corp., Bloomfield, N.J. (*B, D, G, H, I, J, L, N, O, P, Q, S, U*)
● Rubber Corp. of America, Hicksville, N.Y. (*D*)
● Schwartz Chemical Co. Inc., New York (*B, G, S, U*)
The Servwell Products Co., Cleveland, Ohio (*U*)
● Shell Chemical Corporation, New York (*J*)
Skeist Laboratories, Newark, N.J. (*J*)
Specialty Products Co., Jersey City, N.J. (*F*)
● Stanley Chemical Co., East Berlin, Conn. (*D, J, L, U*)
● Swedlow Plastics Co., Youngstown, Ohio (*J*)
Synco Resins Inc., Bethel, Conn. (*O, U*)
● Synthetic Products Co., Cleveland (*J*)
Synvar Corporation, Wilmington, Del. (*D, K, O, Q, T*)
Tylene Plastics, Inc., Michigan City, Ind. (*P, J*)
U B S Chemical Corp., Cambridge, Mass. (*D*)
● Union Carbide International Co., New York (*O, P, Q, R, U*)
Union Paste Co., Hyde Park, Mass. (*A, B, C, D, F, G, I, J, N, O, P, S, T, U*)
Vacuum Coatings, Inc., Wilkinsonville, Mass. (*G, N, P, R, S, L*)
● Valite Div., Valentine Sugars Inc., New Orleans, La. (*O*)
Varcum Chemical Corp., Niagara Falls, N.Y. (*O*)
● Watson-Standard Company, Pittsburgh, Pa. (*U*)
Williamson Adhesives, Inc., Skokie, Ill. (*A, B, C, D, F, J*)
Wilross Products Co., Hawthorne, N.J. (*B, D, G, H, I, J, L, M, N, O, P, Q, R, S, T, U*)
Xylos Rubber Co., Div. of Firestone Tire & Rubber Company, Akron, Ohio (*D, G, I, O, S, U*)

● Indicates Advertiser.

ANTISTATIC AGENTS

● American Cyanamid Co., New York
● Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York
● Archer-Daniels-Midland Co., Chemical Prod. Div., Cleveland, Ohio
BX Plastics Ltd., London, England
● Cadillac Plastic & Chemical Co., Detroit, Mich.
● Carbide & Chemicals Co., New York
Chemical Development Corp., Danvers, Mass.
● Claremont Pigment Dispersion Corp., Roslyn Hghts., New York
Edison, S. M. Chemical Co., Chicago
● Fine Organics, Inc., New York
Industrial & Domestic Silicone Distributor, Reseda, Calif.
Johns-Manville, New York
Kessler Chemical Co., Inc., Philadelphia, Pa.
● Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
● Logo, Inc., Chicago, Ill.
Merix Chemical Co., Chicago
Morton Withers Chemical Co., Greensboro, N.C.
Navarm Chemical Co., Maywood, Calif.
Plastic Center, Rochester, N.Y.
● Polyplastex United, Inc., Union, N.J.
● Schwartz Chemical Co. Inc., New York
Specialty Products Co., Jersey City, N. J.
● Sullivan Varnish Co., Chicago
U. S. Stoneware Co., Akron, Ohio
Wilco Co., Los Angeles
Wilross Products Co., Hawthorne, N.J.

ANTITACK AGENTS

Adhesive Products Corp., New York
● Archer-Daniels-Midland Co., Chemical Prod. Div., Cleveland, Ohio
B.B. Chemical Co., Cambridge, Mass.
Borden Co., Chemical Div., New York
Eveready Pressurized Products, Inc., Cleveland
Mallinckrodt Chemical Works, St. Louis, Mo.
Merix Chemical Co., Chicago
National Adhesives -National Starch Products Inc., New York
Superior Materials Inc., New York
● Synthetic Products Co., Cleveland

BACTERIOSTAT

Bex Industries, Inc., New York
Sanitized Sales Co. of America, New York

CASEIN

For related editorial information see p. 147

Borden Co., Chemical Div., New York
● Harwick Standard Chemical Co., Akron, Ohio
National Casein Co., Chicago
Polymer Chemical Co., Cincinnati, Ohio
Polymer Industries Inc., Springdale, Conn.

CASTING MATERIALS

(Not Cast Products)

For related editorial information see p. 747

A. *Thermoplastic*
B. *Thermosetting*

● Acme Resin Corporation, Forest Pk., Ill. (*B*)
Adhesive Products, Inc., Albany, Calif. (*A, B*)
● Allied Chemical & Dye Corp. Semet-Solvay Petrochemical Div., New York (*A, B*)
● American Cyanimid Co., New York (*B*)
● American Cyanamid Co., Plastics & Resins Div., New York (*B*)
Arabol Mfg. Co., New York (*B*)
Aries Laboratories, Inc., Long Island City, N.Y. (*B*)
● Badische Anilin & Soda Fabrik A. G., Ludroigshafer Rhein, Germany (*A, B*)
Bakelite Co., A Div. of Union Carbide Corp., New York (*A, B*)
● Barrett Div., Allied Chemical & Dye Corp., New York (*B*)
Biggs Co., Carl H. Inc., Los Angeles, (*B*)
Blum, Paul Co., Buffalo, N.Y. (*A*)
Borden Co., Chemical Div., New York (*A*)
Brea Chemicals, Inc., Los Angeles (*A*)
● Catalin Corp. of America, New York (*B*)
● Celanese Corp. of America, Newark, N.J. (*B*)
Chemedical Research Associates, Upper Darby, Penna. (*A, B*)
Chemical Development Corp., Danvers, Mass. (*A, B*)
Chemtron Fiber Glass Co., El Monte, Calif. (*A, B*)
● Cordo Chemical Corp., Norwalk, Conn. (*A, B*)
● Davis, Joseph, Plastics Co., Arlington, N.J. (*A*)
Dow Corning Corp., Midland, Mich. (*B*)
Dreyfus, L. A. Co., Inc., So. Plainfield, N.J. (*A*)
● Durez Plastics Div., Hooker Electro-Chemical Co., North Tonawanda, N.Y. (*B*)
Elastomer Chemical Corp., Newark, N.J. (*A, B*)
Emerson & Cuming, Inc., Canton, Mass. (*A, B*)
Epoxylite, The, Corp., El Monte, Calif. (*B*)
Federal Latex Corp., Brooklyn, N.Y. (*A*)

●Furane Plastics, Inc., Los Angeles (B)
General Mills, Inc., Kankakee, Ill. (A, B)
●Goodrich, B. F. Chemical Co., Cleveland, Ohio (A)
●Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co., Cleveland, Ohio (A, B)
●Hardman, H. V., Co., Belleville, N.J. (B)
Haveg Industries, Inc., Wilmington, Del. (B)
Homalite Co., The, Wilmington, Del. (B)
●Imperial Chemical Industries Ltd., Plastics Div., Hertfordshire, Eng. (A, B)
●Industrial Solvents & Chemicals, Inc., Wilkinsonville, Mass. (A, B)
Ironsides Resins Inc., Columbus, Ohio (B)
●Marblette Corp., The, L. I. C., N.Y. (B)
Marine Plastics, Inc., Clinton, Mass.
●Metal & Thermit Corp., Rahway, N.J. (A)
Minnesota Mining & Mfg. Co., St. Paul, Minn. (B)
Miracle Adhesive Corporation, Bellmore, L.I., N.Y. (A, B)
Mitchell Rand Mfg. Corp., New York (A, B)
●Naugatuck Chemical-U. S. Rubber Co., Naugatuck, Conn. (A, B)
Ohio Adhesives Corp., New Philadelphia, Ohio (A, B)
Poly Resins, Sun Valley, Calif. (A, B)
Polymer Chemical Co., Cincinnati, Ohio (A, B)
Polymer Industries Inc., Springdale, Conn. (A, B)
Ren Plastics Inc., Lansing, Mich. (B)
Rezolin, Inc., Santa Monica, Calif. (B)
Robertson, H. H. Co., Pittsburgh, Pa. (B)
●Rohm & Haas Co., Philadelphia, Pa. (A, B)
●Rubber Corp. of America, Hicksville, N.Y. (A)
●Schwartz Chemical Co., New York (A)
Scientific Abrasives, Chicago (B)
Synvar Corporation, Wilmington, Del. (B)
Technicraft Co., Boston, Mass. (B)
Tylene Plastics Inc., Michigan City, Ind. (B)
Vacuum Coatings, Inc., Wilkinsonville, Mass. (A, B)

CELLULOSE AND CELLULOSE DERIVATIVES

(Flake)

For related editorial information see p. 96

A. *Cellulose*
B. *Cellulose Acetate*
C. *Cellulose Acetate Butyrate*
D. *Cellulose Nitrate*
E. *Cellulose Propionate*
F. *Ethyl Cellulose*
G. *Hydroxyethyl Cellulose*
H. *Methyl Cellulose*
I. *Sodium Carboxymethyl Cellulose*

Amco Plastic Materials, Inc., Brooklyn, N.Y. (B, C, F)
●American Molding Powder & Chemical Corporation, Brooklyn, N.Y. (B)
American Viscose Corp., Philadelphia, Pa. (G)
●Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York (I)
BX Plastics Ltd., London, England (B, D)
Bamberger, Claude P. Inc., Ridgefield Park, N.J. (B, C, F)
Blum, Paul Co., Buffalo, N.Y. (B, C, E)
●Brown Co., Boston, Mass. (A)
Buckeye Cellulose Corp., Memphis, Tenn. (A)
●Carbide & Chemicals Co., New York (G)
●Celanese Corp. of America, Textile Div., Charlotte, N.C. (B, E)
●Dow Chemical Co., Midland, Mich. (F, H)
●du Pont, E.I. de Nemours & Co., Inc., Wilmington, Del. (B, I)
●Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany (D)
●Eastman Chemical Products, Inc., Kingsport, Tenn. (B, C)
Gem City Trading, Dayton, Ohio (B, C)
Hercules Powder Co., Inc., Wilmington, Del. (A, B, D, F, I)
Plastic Materials Inc., Hicksville, N.Y. (B)
Polymer Chemical Co., Cincinnati, Ohio (A, B, D, F, G, H, I)
Rayonier Incorporated, New York (A)
Worbla Ltd., Nr. Berne, Switzerland (E)

CHEMICALS

(See also Monomers)

For related editorial information see P. 364

A. *Acids, Mineral*
B. *Acids, Organic (See also Maleic and Phthalic)*
C. *Alcohols (See also Allyl)*
D. *Aldehyde (See also Formaldehyde and Furfural)*
E. *Alkalies (See also Ammonia)*
F. *Allyl Alcohol*
G. *Amines*
H. *Ammonia*
I. *Benzoyl Peroxide*
J. *Camphor*
K. *Carbon Disulfide*
L. *Catalysts (See also Benzoyl Peroxide and Peroxides)*
M. *Cresol and Cresylic Acid*
N. *Formaldehyde and Paraformaldehyde*
O. *Furfural*
P. *Glycerol*
Q. *Glycols*
R. *Hexamethylenetetramine*
S. *Isocyanates*
T. *Maleic Acid*
U. *Melamine*
V. *Pentaerythritol*
W. *Peroxides*
X. *Phenol*
Y. *Phthalic Anhydride*
Z. *Resorcinol*
AA. *Stearates*
BB. *Urea*
CC. *Xylenol*

●Advance Solvents & Chemical, Div. of Carlisle Chemical Works Inc., New Brunswick, N.J. (AA)
●Allied Chemical & Dye Corporation, National Aniline Div., New York (B, L, S, T, Y)
●American Cyanamid Co., New York (A, B, H, L, M, N, T, U, X, Y, AA, BB)
●American Cyanamid Co. Plastic & Resin Div., New York (T, U, Y, AA)
●Anorgana G. M. B. H., Munchen, Germany (Q)
Applied Plastics, Co., Inc., El Segundo, Calif., (L)
●Archer-Daniels-Midland Co., Chemical Prod. Div., Cleveland, Ohio (C, P)
●Archer-Daniels-Midland Co., Newark, N.J. (C)
●Argus Chemical Corp., Brooklyn, N.Y. (AA)
BX Plastics Ltd., London, England (J)
●Badische Anilin & Soda Fabrik A. G., Ludroigshafer Rhein, Germany (B, C, D, E, H, L, N, Q, R, T, V, Y, BB)
●Barrett Div., Allied Chemical & Dye Corp., New York (B, M, Q, T, X, Y, CC)
Berkshire Chemicals, Inc., New York (A, E, W)
Biggs Carl H. Co., Inc., Los Angeles, (L)
Borden Co., Chemical Div., New York (N, R, T, V)
Brea Chemicals, Inc., Los Angeles, (A, H)
●Cadet Chemical Corp., Lockport-Olcott Road, Burt, N.Y. (I, L, W)
Canadian Resins & Chemicals Ltd., Montreal, Quebec, Canada (C)
●Carbide & Chemicals Co., New York (B, C, D, Q, X)
●Celanese Corp. of America, Chem. Div., New York (B, C, D, M, P, Q)
Chemical Development Corp., Danvers, Mass. (I, L)
●Chemische Werke Huls A. G., Marl, W. Germany (B, C)
Columbia-Southern Chemical Corp., Pittsburgh, Pa. (B, E, H, W)
●Dow Chemical Co., Midland, Mich. (E, H, K, P, Q, X)
●du Pont, E.I. de Nemours & Co., Inc., Wilmington, Del. (A, B, C, E, H, I, N, Q, R, S, W, AA, BB,)
●Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N.Y. (X)
●Eastman Chemical Products, Inc., Kingsport, Tenn. (B, C, D, Q)
Emerson & Cuming, Inc., Canton, Mass. (L)
●Emery Industries, Inc., Cincinnati, Ohio (B)
●Enjay Co., Inc., New York (C)
●Escambia Chemical Corp., New York, (C, H)
Farbwerke Hoechst A. G. vormals Meister Lucius & Brüning, Fim Hoechst, Germany (A, B, C, I, P, T, Z)
●Fine Organics, Inc., New York (B, C, D)
Foremost Food & Chemical Co., El Dorado Div., Oakland, Calif. (B, P)
Garan Chem. Corp., Gardena, Calif. (I, L, U)
●Goodrich, B. F. Chemical Co., Cleveland, Ohio (B)
Greeff, R. W. & Co., Inc., New York (C, D, F, Q, AA, BB)
Gulf Oil Corp., Petrochemicals Dept., Pittsburgh (C, D, V)
●Harshaw Chemical Co., Cleveland (AA)
Hercules Powder Co., Inc., Wilmington, Del. (H, L, V, X)
●Heyden Newport Chemical Corp., New York (A, B, D, N, R, V, Z)
●Hommel, O Co., The, Pittsburgh (C, D, V, Y, AA, BB)

●Indicates Advertiser.

Howards & Sons (Canada) Ltd., Montreal, Ontario, Canada (*C*)
Kay Fries Chemicals, Inc., American British Chemical Supplies, Inc., New York (*B, C, D, L*)
Kolker Chemical Corp., Newark, N.J. (*B, Z*)
●Koppers Co., Inc., Pittsburgh, Pa. (*M, Y, Z*)
●Lucidol Div., Wallace & Tiernan Inc., Buffalo, N.Y. (*I, L, W*)
Mallinckrodt Chemical Works, St. Louis, Mo. (*L, AA*)
●McKesson & Robbins, Inc., N.Y. (*H, K, V*)
●Merck & Co., Inc., Rahway, N.J. (*G, N, R*)
Mobay Chemical Co., St. Louis, Mo. (*S*)
●Monsanto Chemical Co., Springfield, Mass. (*N*)
●Naugatuck Chemical, Naugatuck, Conn. (*S*)
●Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*A, S*)
Oronite Chemical Company, San Francisco, Calif. (*H, M, T, X, Y*)
Pennsylvania Salt Mfg. Co., Phila., Penn. (*A, C, E, H, L*)
Petroleum Chemicals, Inc., New Orleans, La. (*H, Q*)
Philadelphia Quartz Co., Phila, Pa. (*E*)
Pitt Consol Chemical Company, Newark, N.J. (*M, X, CC*)
●Pittsburgh Coke & Chemical, Pittsburgh (*B, M, T, X, Y, CC*)
Poly Resins, Sun Valley, Calif. (*N, X*)
The Quaker Oats Co., Chicago (*C, D, O*)
●Reichhold Chemicals, White Plains, N. Y. (*B, L, N, P, T, V, X, Y*)
●Rohm & Haas Company, Philadelphia, Pa. (*A, B, C, L*)
●Schwartz Chemical Co., New York (*K*)
●Shell Chemical Corp., New York (*C, F, P*)
The Sherwin Williams Co., New York (*M*)
Sigma Specialty Chemicals, Richmond, Calif. (*I, L, W*)
●Specialty Chemicals Inc., Austin, Tex. (*L, W*)
●Spencer Chemical Co., Kansas City, Mo. (*H, N, R*)
●Sun Chemical Corp., Long Island City, N.Y. (*AA*)
Synthetic Products Co., Cleveland (*AA*)
●U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp., New York (*A, B, C, E, H*)
Wagner, Charles A. Co., Inc., Philadelphia, Penna. (*AA*)
●Witco Chemical Co., New York (*AA*)

COATED FABRICS

For related editorial information see p. 468

A. *Cellulosic Coated*
B. *Rubber Coated*
C. *Vinyl Coated*

American Combining Corporation, Rockaway Beach, Queens, N.Y. (*A, B, C*)
Barr Corp., Richmond Hill, N.Y. (*C*)
Blossom Mfg. Co., Inc., New York (*C*)
●Bolta Pdts. Div., General Tire & Rubber Co., Lawrence, Mass. (*C*)
Canadian General-Tower Ltd., Galt, Ontario, Canada (*C*)
Canadian Resins and Chemicals Limited, Montreal, Quebec, Canada (*C*)
Carpenter, L. E. & Co., Wharton, N.J. (*C*)
Clopay Corp., Extruded Film Div., Cincinnati, Ohio (*C*)
Columbus Coated Fabrics Corp., Columbus, Ohio (*C*)
●Cordo Chemical Corp., Norwalk, Conn. (*C*)
●du Pont, E.I. de Nemours & Co., Inc., Wilmington, Del. (*A, B, C*)
Electro-Chemical Products Corp., Cleveland, (*C*)
Electro-Technical Products, Nutley, N.J. (*C*)
Electro Plastic Fabrics, Pulaski, Va. (*C*)
Elm Coated Fabrics Co., Inc., N.Y.C. (*C*)
Farrington Texol Corp., Walpole, Mass. (*A, B, C*)
Federal Industries, Belleville, N.J. (*C*)
Flexfirm Products, El Monte, Calif. (*B, C*)
●Flightex Fabrics, Inc., New York (*C*)
●General Tire & Rubber Co., The, Akron, Ohio (*C*)
●Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co., Marietta, Ohio (*C*)
●Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich, Akron, Ohio (*B, C*)
Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*A, B, C*)
Greeff, R. W., & Co., Inc., New York (*C, D, F, Q, AA, BB*)
Jamestown Finishes, Inc., Jamestown, New York (*C*)
Joanna Western Mills Company, Chicago (*A, C*)
Leathertone, Inc., Boston, Mass. (*C*)
Marbek, Inc., New York (*C*)
Newark Paraffine & Parchment, Newark, N. J. (*A, B, C*)
The Pantasote Company, New York (*C*)
●Plastic Film Corp., Plainfield, Conn. (*C*)
●Polyplastex United, Inc., Union, N.J. (*C*)
Reeves Brothers Inc., New York (*B*)
●Respro. Div. The General Tire & Rubber Co., Cranston, R.I. (*A, B, C*)
Rudd Plastic Fabrics Corp., Bklyn, N. Y. (*C*)
●Sandman Eli Co., Worcester, Mass. (*B, C*)
●Standard Insulation Co., East Rutherford, N. J. (*C*)
Turner Halsey Co., New York (*C*)

COATINGS

(See also Varnishes)

For related editorial information see p. 175

A. *Acrylic Lacquers*
B. *Alkyd Lacquers*
C. *Cellulose Lacquers*
D. *Cellulose Melt Coatings*
E. *Epoxy Coatings*
F. *Furan Coatings*
G. *Melamine Coatings*
H. *Oil Base Coatings*
I. *Phenolic Coatings*
J. *Polyamide Coatings*
K. *Rubber Base Coatings (Natural and Synthetic)*
L. *Silicone Coatings*
M. *Urea Coatings*
N. *Vinyl Coatings*

Adhesive Products Corporation, New York (*A, I, K, N*)
Alkydol Laboratories, Inc., Cicero, Ill. (*E, H, I, K, N*)
Amercoat Corporation, South Gate, Calif. (*E, I, L, N*)
American Hard Rubber Co., New York (*K, N*)
●Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., New York (*I*)
●Angier Adhesives, Div. of Interchemical, Cambridge, Mass. (*E, K, N*)
●Anorgana G. M. B. H., Munchen, Germany, (*N*)
Applied Plastics Co., Inc., El Segundo, Calif. (*E*)
●Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio (*H*)
Aries Laboratories, Inc., Long Island City, N. Y. (*E*)
Armitage, John L Co., Newark, N. J. (*A, B, C, E, G, H, I, J, K, L, M, N*)
Associated Rubber & Plastic Corp., New York (*C, N*)
●Atlas Coatings Corp., Long Island City, N. Y. (*A, B, C, E, I, N*)
Atlas Mineral Products Co., Mertztown, Pa. (*E, F, K, N*)
B. B. Chemical Co., Cambridge, Mass. (*A, K*)
Barrett Varnish Co., Cicero, Ill. (*A, B, C, E, G, H, I, M, N*)
●Belding Corticelli Industries, New York (*J*)
Biggs Carl H. Co., Inc., Los Angeles, (*E*)
Bischoff Chemical Corp., Ivoryton, Conn. (*D*)
Blossom Mfg. Co., Inc., New York (*N*)
Borden Co., Chemical Div., New York (*A, C, D, I, K, N*)
Brutier Products Co., Inc., Secaucus, N. J. (*C*)
Chemedical Research Associates, Upper Darby, Penna. (*E, I, N*)
Chemical Development Corp., Danvers, Mass. (*A, C, E, N*)
●Chemical Products Corp., East Providence, R. I. (*A, B, C, D, E, G, I, J, K, L, M, N*)
Chemtron Fiber Glass Co., El Monte, Calif. (*E*)
Clopay Corp., Extruded Film Div., Cincinnati, Ohio (*N*)
Compo Chemical Co., Mansfield, Mass. (*A, C, E, G, I, J, K, M, N*)
●Cordo Chemical Corp., Norwalk, Conn. (*E, N*)
Custom Coatings Co., Los Angeles, (*A*)
Dennis Chemical Co., St. Louis, Mo. (*A, B, E, I, J, N*)
Doram Products, Inc., Middlesex, N. J. (*L, M*)
Dow Corning Corp., Midland, Mich. (*L*)
Dreyfus, L. A., Co., So. Plainfield, N. J. (*K*)
●du Pont, E. I., de Nemours & Co., Inc., Wilmington, Del. (*A, B, C, H, K*)
Elastomer Chemical Corp., Newark, N. J. (*N*)
Electro-Chemical Products Corp., Cleveland, (*N*)
Electro-Technical Products, Nutley, N. J. (*E, G, H, I, L, M, N*)
Emerson & Cuming, Inc., Canton, Mass. (*E*)
Epoxylite, The, Corp., El Monte, Calif. (*E*)
Eveready Pressurized Products, Inc., Cleveland (*C*)

● Indicates Advertiser.

Farbwerke Hoechst A. G. vermals Meister Lucius & Brüning, Ffm Hoechst, Germany (*C*)
Farrington Texol Corp., Walpole, Mass. (*A, C, K, N*)
Federal Chemicals Corp., Brooklyn, N. Y. (*K, N*)
Federal Latex Corp., Brooklyn, N. Y. (*K, N*)
Flexcraft Industries, Newark, N. J. (*A, B, C, D, N*)
Flexible Products Co., Marietta, Ga. (*N*)
Fuller, H. B., Co., St. Paul, Minn. (*E*)
● Furane Plastics Inc., Los Angeles (*E*)
Garlock Packing Co., The Palmyra, N. Y. (*L*)
General Dispersions Inc., Paterson, N. J. (*J*)
General Mills, Inc., Kankakee, Ill. (*J*)
General Plastics Mfg. Co., Tacoma, Wash. (*A, E, M, N*)
● General Tire & Rubber Co., Toledo, Ohio (*N*)
Glassoloid Corp. of America, Clifton, N. J. (*N*)
● Glidden Co., Cleveland (*A, B, C, E, H, I, J, K, L, M, N*)
● Goodrich, B. F., Industrial Products Co., Akron, Ohio (*K*)
Gordon-Lacey Chemical Products Co. Inc., Maspeth, N. Y. (*K, L, N*)
Gusmer, A, Inc., Stalpic Div., Woodbridge, N. J. (*E, I*)
● H & R Industries, Nazareth, Pa. (*J*)
Haveg Industries, Inc., Wilmington, Del (*K*)
Haynes, C. W. Laboratories, Inc., Springfield, Mass. (*A, B, C, E, G, H, I, K, L, M, N*)
Heresite & Chemical Company, Manitowoc, Wis. (*I, K*)
Houghton Laboratories, Inc., Olean, N. Y. (*E*)
Industrial Latex Co., Wallington, N. J. (*C, K, N*)
Industrial Sales Engineers, New York (*N*)
● Industrial Solvents & Chemicals, Inc., Wilkinsonville, Mass. (*A, B, C, D, E, F, G, I, J, K, L, M, N*)
Interchemical Corp., Finishes Div., Newark, N. J. (*A, B, C, D, E, G, H, I, K, L, M, N*)
Jamestown Finishes, Inc., Jamestown, N. Y. (*A, B, C, E, G, H, M, N*)
Jones-Dabney Co., Louisville, Ky. (*A, B, C, D, G, H, I, J, K, L, M, N*)
Keystone Refining Co., Inc., Philadelphia, Pa. (*A, E, G, H, I, J, K, L, M, N*)
Krylon, Inc., Norristown, Pa. (*A, B*)
L & P Tool Co., Cincinnati, Ohio (*N*)
Lami-Plast Products Co., Tampa, Fla. (*E*)
Lithgow Chemicals Co., Div. of Reinhold Engineering & Plastics Co., Norwalk, Calif. (*E, F, I, K, N*)
● Logo, Inc., Chicago, Ill. (*A, B, C, E, G, H, I, J, K, L, M, N*)
Magic Chemical Co., Brockton, Mass. (*A, B, C, D, E, F, G, H, I, J, K, L, M, N*)
Marbek, Inc., Brooklyn, N. Y. (*N*)
● Marblette Corp., L.I.C., N. Y. (*E, I*)
McCloskey Varnish Co., Philadelphia, Pa. (*E, H, I*)
● Metal & Thermit Corp., Rahway, N. J. (*A, B, C, E, G, I, M, N*)
● Michigan Chrome & Chemical Co., Detroit (*E, N*)
Midland Adhesive & Chemical Corp., Ferndale, Mich. (*A, C, K, N*)
Miracle Adhesive Corporation, Bellmore, L.I., N. Y. (*A, E, I, K, N*)
Mol-Rez Division-American Petrochemical corp., Minneapolis, Minn. (*B*)
Moore, Samuel & Co., Mantua, Ohio (*N*)
Murray Plastics Co., Poughkeepsie, N. Y. (*I*)
National Adhesives-National Starch Products Inc. New York (*N*)
● National Polymer Products, Inc., Reading (*D, E, J*)
● Naugatuck Chemical, Naugatuck, Conn. (*K, N*)
● Naugatuck Chem. U. S. Rubber Co., Naugatuck, Conn. (*B, K, N*)
Navarm Chemical Co., Maywood, Calif. (*K, N*)
Ohio Adhesives Corp., New Philadelphia, Ohio (*A, E, I, K, N*)
Paisley Products Inc., New York (*K, N*)
Parcloid Chemical Co., Midland Park, N. J. (*N*)
Pelron Corporation, Lyons, Ill. (*N*)
Pierce & Stevens Chem. Corp., Buffalo, N. Y. (*A, B, C, E, G, I, J, K, L, M, N*)
● Pittsburgh Plate Glass Co., Pgh., Pa. (*A, B, C, E, G, H, I, K, M, N*)
Plastic Film Corp., Plainfield, Conn. (*N*)
● Plastics Engineering Co., Sheboygan, Wis. (*I*)
Poly Resins, Sun Valley, Calif. (*D, E, I, N*)
Polykote, Inc., Cleveland (*E, I, J, K, N*)
Polymer Chemical Co., Cincinnati, Ohio (*A, C, J, K, M, N*)
● Polymer Corporation, Reading, Penn. (*D, E, J, N*)
Polymer Industries Inc., Springdale Conn. (*E, N*)
● Polypenco, Inc., Reading, Pa. (*D, E, J*)
Protective Treatments, Inc., Dayton, Ohio (*A, N*)
Pyroxylin Products Inc., Chicago, Ill. (*A, B, C, D, G, J, K, M, N*)
Raffi and Swanson, Inc., Wilmington, Mass. (*A, B, C, G, I, M, N*)
Randolph Products Co., Carlstadt, N. J. (*A, B, C, G, J, K, L, M, N*)
Reeves Brothers, Inc., New York (*K*)
Ren Plastics Inc., Lansing, Mich. (*E*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*N*)
Resolite Corporation, Zelienople, Pa. (*A*)
Rexton Finishes, Inc. Irvington, N. J. (*A, B, C, E, G, I, J, K, M, N*)
● Reynolds Chemical Products Co., Ann Arbor Mich. (*E, N*)
Rezolin, Inc., Santa Monica, Calif. (*E*)
● Rubber & Asbestos Corp., Bloomfield, N. J. (*K*)
● Rubber Corp. of America, Hicksville, N. Y. (*K, N*)
● Sandman Eli Co., Worcester, Mass. (*E, G, I, J, K, L, M, N*)
Schenectady Varnish Co. Inc., Schenectady, N. Y. (*H, I, J*)
● Schwartz Chemical Co., New York (*A, C, I, M, N*)
Seal Peel Inc., Royal Oak, Michigan (*D*)
Servwell Products Co., Cleveland. Ohio (*N*)
Sherwin Williams Co., New York (*A, B, C, D, E, F, G, H, I, J, K, L, M, N*)
Sorg Paper Co., Middletown, Ohio (*A, B, C, E, G, I, J, K, L, M, N*)
Spraylat Corporation, New York (*K, N*)
● Stanley Chemical Co., East Berlin, Conn. (*A, B, C, D, E, G, H, I, J, K, L, M, N*)
● Sullivan Varnish Co., Chicago (*A, B, C, E, G, H, I, K, L, M, N*)
● Sun Chemical Corp., Long Island City, N. Y. (*A, G, I, M, N*)
Truscon Laboratories, Detroit (*E, H, K, L, N*)
Tylene Plastics, Inc., Michigan City, Ind. (*E, J, N*)
U B S Chemical Corp., Cambridge, Mass. (*K*)
U.S. Stoneware Co., Akron, Ohio (*B, E, F, I, N*)
Vacuum Coatings, Inc., Wilkinsonville, Mass. (*A, B, C, D, E, F, G, I, J, K, L, M, N*)
● Valite Div., Valentine Sugars Inc., New Orleans, La. (*I*)
Varcum Chemical Corp., Niagara Falls, N. Y. (*I*)
Westinghouse Electric Corp., Micarta Div., Hampton, S. C. (*E, G, H, I, L*)
● Watson-Standard Company, Pitts., Pa. (*A, B, E, G, H, I, K, L, M, N*)
Western Coating Co., Royal Oak, Mich. (*D*)
Western Plastic Inc., Spokane, Wash. (*N*)
Wilross Products Co., Hawthorne, N. J. (*A, B, C, D, E, G, H, I, J, K, L, M, N*)
Xylos Rubber Co., Div. of Firestone Tire & Rubber Company, Akron, Ohio (*K*)

COLOR DISPERSIONS IN RESINS AND PLASTICIZERS

(For related editorial information see p. 367

● Acheson Dispersed Pigments Co., Phila., Pa.
● American Molding Powder & Chemical Corporation, Brooklyn, N. Y.
● Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., New York
Applied Plastics Co., Inc., El Segundo, Calif.
● Argus Chemical Corp., Brooklyn, New York
● Atlas Coatings Corp., Long Island City, N. Y.
Blane Corp., Canton, Mass.
California Ink Co., The Inc., San Francisco,
● Chemical Products Corp., East Providence, R. I.
● Claremont Pigment Dispersion Corp., Roslyn Heights, New York
● Columbian Carbon Co., New York
● du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
Farrington Texol Corp., Walpole, Mass.
● Ferro Corp., Plastic Color Div., Cleveland
● Furane Plastics Inc., Los Angeles
Garan Chem. Corp., Gardena, Calif.
● General Dyestuff Co., Sales Div. of General Aniline & Film Corp., New York
● Glidden Co., Baltimore, Md.
● Goodrich, B. F. Chemical Co., Cleveland, Ohio
Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y.
● Harwick Standard Chemical Co., Akron, Ohio
Houghton Laboratories, Inc., Olean, N. Y.

● Indicates Advertiser.

Interchemical Corp., Finishes Div., Newark, N. J.
Jamestown Finishes, Inc., Jamestown, N. Y.
●Kentucky Color & Chemical Co., Louisville, Ky.
Keystone Refining Co., Inc., Philadelphia, Pa.
●Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
Landers-Segal Color Co., Brooklyn, N. Y.
●Logo, Inc., Chicago, Ill.
●Luminous Resins Inc., Chicago, Ill.
Mol-Rez Division-American Petrochemical Corp., Minneapolis, Minn.
Navarm Chemical Co., Maywood, Calif.
C. J. Osborn Company, Linden, N. J.
Penna. Color & Chemical Co., Doylestown, Penna.
●Plastic Molders Supply Co., Inc., Fanwood, N. J.
Plastic Molding Powders Inc., Brooklyn, N. Y.
●Plastics Color Co., Chatham, N. J.
Premier Thermo Plastics Co., Jeffersontown, Ky.
●Reichhold Chemicals, Inc., White Plains, N. Y.
Schori Process Division of Ferro-Co. Corp., New York
●Schwartz Chemical Co. Inc., New York
The Sherwin Williams Co., New York
Standard Ultramarine & Color, Huntington, W. V.
●Stanley Chemical Co., East Berlin, Conn.
●Sullivan Varnish Co., Chicago
Technicraft Co., Boston, Mass.
Vansul Sales Co., Englewood, N. J.
●Westchester Plastic, Inc., Mamaroneck, N.Y.

COLORANTS FOR DRY COLORING

(For related editorial information see p. 367

●Allied Chemical & Dye Corp., National Aniline Div., New York
●American Cyanamid Co., Organic & Pigments Div., New York
●American Cyanamid Co., New York
●American Molding Powder & Chemical Corp., Brooklyn, N. Y.
Blane Corp., Canton, Mass.
●Cabot, Godfrey L., Inc., Boston, Mass.
Colors Unlimited, Los Angeles
●Drakenfeld, B. F. & Co., Inc., New York
●du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
●Ferro Corp., Plastic Color Div., Cleveland
●General Dyestuff Co., Sales Div. of General Aniline & Film Corp., New York
●Glidden Co., Baltimore, Md.
●Harshaw Chemical Co., Cleveland
●Harwick Standard Chemical Co., Akron, Ohio
Imperial Paper & Color Corp., Pigment Color Div., Glens Falls, New York
●Interplastics Corp., New York
●Kentucky Color & Chemical Co., Louisville, Ky.
Kohnstamm, H. & Co., Inc., New York
●Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
Landers-Segal Color Co., Brooklyn, N. Y.

●Indicates Advertiser.

●Luminous Resins Inc., Chicago, Ill.
●Mapico Color Unit, Columbian Carbon Co., New York
Homer W. Palmer & Company, Chicago
Penna Color & Chemical Co., Doylestown, Penna.
●Plastic Molders Supply Co., Inc., Fanwood, N. J.
●Plastics Color Co., Chatham, N. J.
●Reichhold Chemicals, Inc., White Plains, N. Y.
●Riverdale Color Co., Inc., Newark, N. J.
Riverdale Plastics & Chem. Corp., Culver City, Calif.
●Schwartz Chemical Co. Inc., New York
The Sherwin Williams Co., New York
Smith Chemical & Color Co., Inc., Bklyn., N. Y.
Standard Ultramarine & Color Co., Huntington, W. V.
Titanium Pigment Corp., New York
Paul Uhlich & Co., Inc., New York
Vansul Sales Co., Englewood, N. J.
●Westchester Plastics, Inc., Mamaroneck, N.Y.
●Witco Chemical Co., New York

CORES FOR SANDWICH CONSTRUCTION

Balsa Ecuador Lumber Corp., New York
Chemtron Fiber Glass Co., El Monte, Calif.
Magic Chemical Co., Brockton, Mass.

DEODORANTS

Chemical Development Corp., Danvers, Mass.
Fritzsche Brothers, Inc., New York

DYES
(See also Pigments)

For related editorial information see p. 367

●Allied Chemical & Dye Corporation National Aniline Div., New York
●American Cyanamid Co., New York
●American Cyanamid Co., Organic & Pigments Div., New York
●American Molding Powder & Chemical Corporation, Brooklyn, New York
●Badische Anilin & Soda Fabrik A. G., Ludroigshafer Rhein, Germany
Colors Unlimited, Los Angeles
●du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
Farbwerke Hoechst A. G. vormals Meister Lucius & Brüning, Hoechst, Germany
●Harshaw Chemical Co., Cleveland
●Kentucky Color & Chemical Co., Louisville, Ky.
●Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
Plastic Molding Powders Inc., Brooklyn, N. Y.
●Plastics Color Co., Chatham N. J.
●Schwartz Chemical Co., Inc., New York
●Sullivan Varnish Co., Chicago, Ill.
Vansul Sales Co., Englewood, N. J.

EMULSIFYING AND DISPERSING AGENTS

Adhesive Products Corporation, New York
●Allied Chemical & Dye Corporation National Aniline Div., New York
●Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., New York
●American Cyanamid Co., New York
●Anorgana G. M. B. H., Munchen, Germany
●Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York
●Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio
Atlas Powder Co., Wilmington, Del.
●Badische Anilin & Soda Fabrik A. G., Ludroigshafen Rhein, Germany
Borden Co., Chemical Div., New York
●Carbide & Chemicals Co., New York
●Dewey & Almy Chemical Co., of W. R. Grace & Co., Cambridge, Mass.
●du Pont, E. I., de Nemours & Co., Inc., Wilmington, Del.
Farbwerke Hoechst A. G. vormals Meister Lucius & Brüning, Ffm Hoechst, Germany
Glyco Products Co., Inc., New York
Greeff, R. W., & Co., Inc., New York
Kessler Chemical Co., Inc., Philadelphia, Pa.
●Krieger Color & Chemical Co. Inc., Los Angeles, Calif.
Merix Chemical Co., Chicago
Morton Withers Chemical Co., Greensboro, N. C.
Plastic Molding Powders Inc., Brooklyn, N. Y.
●Plastics Color Co., Chatham, N. J.
●Rohm & Haas Company, Philadelphia, Pa.,
●Witco Chemical Co., New York

EMULSIONS AND DISPERSIONS

For related editorial information see P. 340

A. *Cellulose Base*
B. *Protein Base*
Resin Base
C. *Acrylic Resins*
D. *Alkyd Resins*
E. *Allyl Resins*
F. *Coumarone-Indene Resins*
G. *Fluorocarbon Resins*
H. *Furan Resins*
I. *Isocyanate Resins*
J. *Melamine Resins*
K. *Phenolic Resins*
L. *Polyamide Resins*
M. *Polyester Resins*
N. *Resorcinol Resins*
O. *Rubber Base*
P. *Styrene Resins*
Q. *Vinyl Resins*

Acco Polymers, New York (*C*)
●Acheson Dispersed Pigments Co., Philadelphia, Penna. (*A, C, I, J, M, P, Q*)
●Acme Resin Corporation, Forest Pk., Ill., (*G, K*)
Adhesive Products Corporation, New York (*C, D, F, K, O, P, Q*)
Alkydol Laboratories, Incorporated, Cicero, Ill. (*B, D, K*)
●American Agile Corporation, Maple Hts., Ohio (*G*)
●American Cyanamid Co., New York (*C, D*)
●American Cyanamid Co. Plastic & Resin Div., New York (*J*)
●Angier Adhesives, Div. of Interchemical, Cambridge, Mass. (*F*)
●Anorgana G.M.B.H., Munchen, Germany (*Q*)
Arabol Mfg. Co., New York (*B, Q*)
●Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio (*B, D, M*)
Aries R. S. & Associates, New York (*C, D, P*)
Armitage John L. & Co., Newark, N. J. (*C, D, Q*)

●Auburn Button Works, Inc., Auburn, N.Y. (*Q*)
BX Plastics Ltd., London, England (*A, P*)
B. B. Chemical Co., Cambridge, Mass. (*C, I, O*)
●Bodische Anilin & Soda Fabric A. G., Ludroigshafen Rhein, Germany (*C, L, M, P, Q*)
●Bakelite Co., A Div. of Union Carbide Corp., New York (*K, P, Q*)
●Belding Corticelli Industries, New York (*L*)
Booty Resineers, Inc., Newark, Ohio (*K, L, M*)
Borden Co., Chemical Div., New York (*C, F, O, P, Q*)
British Geon Limited, London, W. I., England (*Q*)
●Cadillac Plastic & Chemical Co., Detroit (*C, M, P*)
California Ink Co., Inc., San Francisco (*M, O*)
●Catalin Corp. of America, New York (*J*)
●Celanese Corp. of America, Newark, N. J. (*Q*)
Colton Chemical Co., A Div. of Air Reduction Co., Inc., Cleveland (*Q*)
●Columbian Carbon Company, New York, New York (*A, C, D, P*)
Dennis Chemical Co., St. Louis, Mo. (*Q*)
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass. (*O, Q*)
●Dow Chemical Co., Midland, Mich. (*P, Q*)
●du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*I, Q*)
Elastomer Chemical Corp., Newark, N. J. (*Q*)
Electro-Chemical Products Corp., Cleveland, (*Q*)
Farbwerke Hoechst A. G. vormals Meister Lucius & Brüning, Hoechst, Germany (*Q*)
Farrington Texol Corp., Walpole, Mass. (*C, O, Q*)
Federal Chemicals Corp., Brooklyn, N. Y. (*Q*)
Federal Latex Corp., Brooklyn, N. Y. (*C, O, P, Q*)
●Firestone Plastics Co., Pottstown, Pa. (*Q*)
Flexible Products Co., Marietta, Ga. (*Q*)
General Dispersions Inc., Paterson, N. J. (*L*)
General Mills, Inc., Kankakee, Ill. (*L*)
General Plastics Mfg. Co., Tacoma, Wash. (*C*)
●General Tire & Rubber Co., Chemical Div., Akron, Ohio (*O*)
●Goodrich, B. F., Chemical Co., Cleveland, Ohio (*O, Q*)
●Goodrich, B. F., Industrial Products Co., Akron, Ohio (*O*)
●Goodyear Tire & Rubber Co., The, Chemical Div., Akron, Ohio (*O, Q*)
Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*Q*)
Haveg Industries, Inc., Wilmington, Del. (*H, K*)
Haynes, C. W. Laboratories, Inc., Springfield, Mass. (*B*)
●Hommel, O. Co., The, Pittsburgh (*D, J, K*)
Industrial Latex Co., Wallington, N. J. (*B, C, D, H, J, O, Q*)
●Industrial Solvents & Chemicals, Inc., Wilkinsonville, Mass. (*I, Q*)
Interchemical Corp., Finishes Div., Newark, N. J. (*M, Q*)
Ironsides Resins Inc., Columbus, Ohio (*K*)
Kellogg, M. W., Co., Jersey City, N. J. (*H*)
●Koppers Co., Inc., Pittsburgh, Pa. (*N, P*)
L & P Tool Company, Cincinnati, Ohio (*N, P*)
Lithgow Chemicals Co., Div. of Reinhold Engineering & Plastics Co., Norwalk, Calif. (*P*)
●Luminous Resins Inc., Chicago, Ill. (*M*)
Midland Adhesive & Chemical Corp., Ferndale, Mich. (*B, O, Q*)
Miracle Adhesive Corp., Bellmore, L.I., N.Y. (*B, O*)
●Monsanto Chemical Co., Springfield, Mass. (*O, Q*)
National Adhesives-National Starch Products Inc. (*O, Q*)
●Naugatuck Chemical, Naugatuck, Conn. (*O, P, Q*)
●Naugatuck Chemical, U. S. Rubber Co., Naugatuck, Conn. (*O, D, M, Q*)
Navarm Chemical Co., Maywood, Calif. (*O, C, D, P, Q*)
Ohio Adhesives Corp., New Phila., Ohio (*B, O*)
Paisley Products Inc., New York
Parcloid Chemical Co., Midland Park, N. J. (*Q*)
Pelron Corporation, Lyons, Ill. (*M, Q, I*)
Pennsylvania Industrial Chemical Corp., Clairton, Penna. (*F*)
●Peters Chemical Mfg. Co., Melrose Park, Ill. (*C*)
Plastic Molding Powers Inc., Brooklyn, N. Y. (*P, Q*)
●Plastics Color Co., Chatham, N. J. (*C, M, P, Q, I*)
Polymer Chemical Co., Cincinnati, Ohio (*A, B, O, C, F, K, L, M, N, P, Q*)
●Reichhold Chemicals, Inc., White Plains, N. Y. (*D*)
●Reynolds Chemical Products Co., Ann Arber, Mich. (*J, Q*)
●Rohm & Haas Co., Philadelphia, Pa. (*C*)
●Rubber Corp. of America, Hicksville, N. Y. (*O*)
Servwell Products Co., Cleveland, Ohio (*Q*)
Spraylat Corporation, New York (*O, C, Q*)
●Stanley Chemical Co., East Berlin, Conn. (*Q*)
Synco Resins Inc., Bethel, Conn. (*K, Q*)
Synvar Corporation, Wilmington, Del. (*H, K, N*)
Technicraft Co., Boston, Mass. (*Q*)
Truscon Laboratories, Detroit (*Q*)
U B S Chemical Corp., Cambridge, Mass. (*O, C, P*)
●Union Carbide International Co., New York (*P, Q*)
U. S. Plastic Products Corp., Metuchen, N. J. (*C, M*)
Vacuum Coatings, Inc., Wilkinsonville, Mass. (*Q, I*)
Varcum Chemical Corp., Niagara Falls, N. Y. (*K*)
●Watson-Standard Company, Pitts. Pa. (*O, C, D, Q*)
Westinghouse Electric Corp., Micarta Div., Hampton, S. C. (*E, K, M*)
Wilcox Products Co., Hawthorne, N. J. (*C, D, E, F, J, K, L, M, N, O, P, Q*)
Witco Chemical Co., New York (*M*)
Xylos Rubber Co., Div. of Firestone Tire & Rubber Company, Akron, Ohio (*B, F, O*)

EXPANDED (FOAMED) PLASTICS

(See also, Cores for Sandwich Construction)

For related editorial information see P. 334

A. *Cellulose Base*
B. *Composite Structures* (Honeycomb, etc.)
C. *Isocyanate Resin*
D. *Phenolic Resin*
E. *Rubber Base*
F. *Styrene Resin*
G. *Urea Resin*
H. *Vinyl Resin*

American Hard Rubber, New York (*E*)
American Latex Corp., Los Angeles (*C, E*)
Atlas Mineral Products Co., Mertztown, Pa. (*C*)
●Auburn Button Works, Inc., Auburn, N.Y. (*H*)
BX Plastics Ltd., London, England (*F*)
●Badische Anilin & Soda Fabrik A. G., Ludroigshafen Rhein, Germany (*F*)
Balsa Ecuador Lumber Corp., New York (*B*)
●Bolta Pdts. Div., General Tire & Rubber Co., Lawrence, Mass. (*H*)
California Ink Co., The Inc., San Francisco (*C*)
Chase Chemical Co., Pitts., Penna.
Chemedical Research Associated, Upper Darby, Penna. (*H*)
●Chemical Products Corp., East Providence, R. I. (*H*)
Chemtron Fiber Glass Co., El Monte, Calif. (*B*)
Colton Chemical Co., A Div. of Air Reduction Co., Inc., Cleveland, Ohio (*G*)
Continental Can Co., Inc., Shellmar-Betner Div., Mt. Vernon, Ohio (*B*)
Crest Chemical Industries Corp., Brooklyn, N. Y. (*C, H*)
Dayton Rubber Co., Dayton, Ohio (*E*)
●Douglas Aircraft Co., Inc., Santa Monica, Calif. (*B*)
●Dow Chemical Co., Midland, Mich. (*F*)
Dyfoam Corp., New Castle, Pa. (*F*)
Elastomer Chemical Corp., Newark, N. J. (*H*)
Emerson & Cuming, Inc., Canton, Mass. (*C, F*)
Flexible Products Co., Marietta, Ga. (*H*)
Floatex, Inc., Berlin Conn. (*H*)
Foam King, Inc., Bronx, New York (*H*)
Frank Plastics Corp., Detroit (*F*)
●General Electric Co., Chemical & Materials, Pittsfield, Mass. (*D*)
General Plastics Mfg. Co., Tacoma, Wash. (*C*)
●Goodrich, B. F. Chemical Co., Cleveland, Ohio (*H*)
●Hexcel Products, Oakland, Calif. (*B*)
Interchemical Corp., Finishes Div., Newark, N. J. (*H*)
International Balsa Corporation, Jersey City, N. J. (*B*)
Isocyanate Pdts., Wilmington, Del. (*C*)
●Koppers Co., Inc., Pittsburgh, Pa. (*F*)
L & P Tool Co., Cincinnati, Ohio (*H*)
Magic Chemical Co., Brockton, Mass. (*C, H*)
●Marblette Corp., L. I. C., N. Y. (*D*)
McMillan Industrial Corp., Ipswich, Mass. (*B*)

●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

●Mono-Sol-Corporation, Gary, Indiana (*H*)
●Monsanto Chemical Co., Springfield, Mass. (*F*)
●Naugatuck Chemical-U.S. Rubber Co., Naugatuck, Conn. (*C*)
Parcloid Chemical, Midland Park, N. J. (*H*)
Pelron Corporation, Lyons, Ill. (*C*)
●Pittsburgh Plate Glass Co., Pgh., Pa. (*C*)
Poly Resins, Sun Valley, Calif. (*D, H*)
Rezolin, Inc., Santa Monica, Calif. (*D*)
●Reynolds Chemical Products Co., Ann Arbor, Mich. (*C, H*)
Robinson Moulded Products Ltd., Toronto, Ont. (*C, H*)
●Rogers Corporation, Rogers, Conn. (*E*)
●Rohm & Haas Co., Philadelphia, Pa. (*C*)
Standard Plastics, Inc., Breinigsville, Pa. (*C, F, H*)
Strick Plastics, Perkasie, Penna. (*B, C, F*)
●Swedlow Plastics Co., Youngstown, Ohio (*B*)
Albert Trostel & Sons Co., Milwaukee, Wis. (*C*)
●Watson-Standard Company, Pitts. Pa. (*H*)

EXTENDERS

Berkshire Chemicals, Inc., New York
●Cabot, Godfrey L. Inc., Boston, Mass.
●Diamond Alkali Co., Chlorowax Div., Cleveland
●Hayden Mica Co., Wilmington, Mass.
Hercules Powder Co., Inc., Wilmington, Del.
Johns-Manville, New York
Weyerhaeuser Timber Co., Tacoma, Wash.
●Witco Chemical Co., New York

FABRICS

(For Laminating)

For related editorial information see P. 506

A. Asbestos
B. Cotton
C. Dacron
D. Glass Cloth and Mat
E. Nylon
F. Orlon
G. Rayon
H. Misc. Synthetic

American Viscose Corp., Philadelphia, Pa. (*G*)
Bean, D. D., & Sons Co., Fiber Glass Div., Jaffrey, N. H. (*D*)
●Coast Mfg. & Supply Co., Livermore, Calif. (*A, B, D*)
Duofold, Inc., Mohawk, N. Y. (*D*)
Famco, Inc., Louisville, Ky. (*D*)
●Ferro Corp., Fiber Glass Div., Nashville, Tenn. (*D*)
●Flightex Fabrics, Inc., New York (*B, C, D, E, F, G, H*)
Garlock Packing Co., Palmyra, N. Y. (*A*)
Johns-Manville, New York (*A*)
Leathertone, Inc., Boston, Mass. (*H*)
Lynch Asbestos Co., Los Angeles, Calif. (*D*)
Marmyte Co., Mundelein, Ill. (*D*)
North American Asbetos Corp., Chicago (*A*)
Pellon Corporation, New York (*B, C, E, F, G, H*)
●Polyplastex United, Inc., Union, N. J. (*D*)
Raybestos Manhattan Inc., Manheim, Pa. (*A, D*)
Ren Plastics Inc., Lansing, Mich., (*D*)
●Sandman Eli Co., Worcester, Mass. (*B, D*)
Stevens J. P. & Co., Inc., New York (*B, C, D, E, F, G, H*)
Thalco, Los Angeles (*D*)
Thomaston Mills, Thomaston, Ga. (*B*)
Thompson H. I., Fiber Glass Co., Los Angeles (*D*)
●Troy Blanket Mills, New York (*C, E, F, H*)
Turner Halsey Co., New York (*A, B, C, E, G, H*)
●Wellington Sears Co., Inc., New York (*B, C, E, F, G, H*)

FABRICS, WOVEN

(Plastic)

American Rattan & Reed, Brooklyn, N. Y.
●Colonial Kolonite Co., Chicago
Ferplex Chemicals Inc., New York
Leathertone, Inc., Boston, Mass.
●Sandman, Eli Co., Worcester, Mass.
Stevens, J. P. & Co., Inc., New York
●Wellington Sears Co., Inc., New York

FIBERS AND FILAMENTS SYNTHETIC

(Monofilaments)

For related editorial information see Fibers Chart, p. 580

●American Cyanamid Co., New York
BX Plastics Ltd., London, England
●Carbide & Chemicals Co., New York
Dawbarn Bros., Inc., Waynesboro, Va.
●du Pont, E. I., de Nemours & Col. Inc., Wilmington, Del.
●Eastman Chemical Products, Inc., Kingsport, Tenn.
●Flightex Fabrics, Inc., New York
●National Plastic Prod. Co., Odenton, Mo.
●Rayon Processing Co. of R.I., Pawtucket, R.I.

FIBRE, VULCANIZED

(Sheets, Rods, Tubes, etc.)

For related editorial information see p. 174

●Colonial Kolonite Co., Chicago
●Continental-Diamond Fibre Corp., Newark, Del.
Franklin Fibre-Lamitex Corp., Wilmington, Del.
●National Vulcanized Fibre Co., Wilmington Del.
Spaulding Fibre Co., Inc., Tonawanda, N. Y.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., New Castle, Del.

FILLERS

For related editorial information see p. 468

A. Alpha Cellulose
B. Carbon Black
C. Chalk
D. Cocoanut Shell Flour
E. Cord
F. Cotton Flock
G. Cottonseed Hulls
H. Fabric (Macerated or Chopped)
I. Glass Fiber and Fabric
J. Metallic
K. Mineral (Asbestos, Mica, Silica, etc.)
L. Sisal
M. Walnut Shell Flour
N. Wood Flour

Agrashell, Inc., Los Angeles, (*M*)
Balsa Ecuador Lumber Corp., New York (*N*)
Basic Plastic Materials, Inc., Winchester, N. H. (*F*)
Bean, D. D. & Sons Co., Fiber Glass Div., Jaffrey, N. H. (*I*)
Berkshire Chemicals, New York (*C, K*)
●Brown Company, Boston, Mass. (*A*)
Buckeye Cellulose Corp., Memphis, Tenn. (*A, F*)
●Cabot, Godfrey L., Inc., Boston, Mass. (*B, K*)
●Chemische Werke Huls A.G., Marl, W. Germany (*B*)
●Claremont Waste Mfg. Co., Claremont, N. H. (*F, H*)
Columbia Southern Chemical Co., Pittsburgh, Pa. (*K*)
●Columbian Carbon Co., New York (*B*)
Composition Materials Co., Inc., New York (*F, H, L, M, N*)
Danberg Chemical Co., Wallingford, Conn. (*A, E, F, H, L*)
●Diamond Alkali Co., Chlorowax Div., Cleveland (*C*)
Doggett, Stanley, Inc., New York (*B, K*)
Dow Corning Corp., Midland, Mich. (*K*)
Eagle-Picher Co., The, Cincinnati, Ohio (*K*)
●English Mica Co., Stamford, Conn. (*K*)
Famco, Inc., Louisville, Ky. (*I*)
Garvan, P., Inc., Hartford, Conn. (*H*)
General Fibre Co., Inc., Walpole, Mass. (*A, E, F, H*)
Georgia Kaolin Co., Elizabeth, N. J. (*K*)
Greeff, R. W., & Co., New York (*B*)
●Harwick Standard Chemical Co., Akron, Ohio (*H, M*)
●Hayden Mica Co., Wilmington, Del. (*K*)
●Hommel, O. Co., The, Pittsburgh (*J, K*)
International Filler Corp., N. Tonawanda, N. Y. (*F, H, N*)
International Textile Co., Chicago, Ill. (*E, F, H, I, K, L*)
Johns-Manville, New York (*K*)
Landers-Segal Color Co., Brooklyn, N. Y. (*B, C, K*)
Leathertone, Inc., Boston, Mass. (*J*)
Lignum Chemical Works, The, L. I. C., N. Y. (*N*)
●Metals Disintegrating Co., Summit, N. J. (*J*)
Miller, Frank & Sons, Chicago (*N*)
●Minerals & Chemical Corp. of America, Menlo Park, N. J. (*K*)
Mundane Company, Verplanck, N. Y. (*F*)
North American Asbetos Corp., Chicago (*K*)
Pellon Corporation, New York (*H*)
Philadelphia Quartz Co., Philadelphia, Pa. (*K*)
Plastics Materials Corp., Windham, Maine (*N*)
Pluess Staufer, New York (*C*)
●Plymouth Fibres, Inc., Brooklyn, N. Y. (*F, H*)
●Powhaten Mining Co., Baltimore, Md. (*K*)
Raybestos Manhattan Inc., Manheim, Pa. (*K*)
●Rayon Processing Co. of R.I., Pawtucket, R. I. (*E, F, H, J, L*)
Rayonier Incorporated, New York (*A*)
●Sandman, Eli Co., Worcester, Mass. (*I*)

●Indicates Advertiser.

Sirotta Bernard Co., Brooklyn, N. Y. (*D, M, N*)
Smith Chemical & Color Co., Inc., Bklyn., N. Y. (*C*)
Standard-Union Fibre Co., Philadelphia, Pa. (*L*)
Superior Materials Inc., New York (*K*)
Synthetic Mica Corp., Caldwell TWP, N. J. (*K*)
Thomaston Mills, Thomaston, Ga. (*E*)
●U. S. Gypsum Co., Chicago (*K*)
Wagner, Charles A. Co., Inc. (*C, K, N*)
Weyerhaeuser Timber Co., Tacoma, Wash. (*N*)
● Witco Chemical Co., New York (*B*)
Wood Flour, Inc., Winchester, N. H. (*N*)

FILM, PLASTIC
(Sheeting and Rolls)

(See also Vinyl Film, Sheeting and Coated Fabric Manufacturers)

A. *Cellophane (Regenerated Cellulose)*
B. *Cellulose Acetate*
C. *Cellulose Acetate Butyrate*
D. *Cellulose Nitrate*
E. *Cellulose Propionate*
F. *Cellulose Triacetate*
G. *Ethyl Cellulose*
H. *Fluorocarbons*
I. *Multidirectional stretched*
J. *Nylon (Polyamide)*
K. *Polyethylene*
L. *Polystyrene*
M. *Polyvinyl Acetate*
N. *Polyvinyl Alcohol*
O. *Polyvinyl Butyral*
P. *Polyvinyl Chloride*
Q. *Polyvinyl Chloride Acetate*
R. *Polyvinyl Chloride-Vinylidene Chloride*
S. *Polyvinylidene Chloride*
T. *Sodium Carboxymethyl Cellulose*

●Acme Resin Corporation, Forest Pk., Ill. (*H*)
●American Agile Corporation, Maple Hts., Ohio (*K*)
American Pyroxylin Corporation, Arlington, N. J. (*B, D*)
American Viscose Corp., Philadelphia, Pa. (*A*)
●Amos Packaging, Edinburg, Indiana (*K*)
● Anorgana G.M.B.H., Munchen, Germany (*P*)
Argo Plastic Products, Cleveland (*K*)
Armen, Inc., Long Island City, N. Y. (*H*)
Associated Rubber & Plastic Corp., New York (*P*)
BX Plastics Ltd., London, England (*B, D, F, K, L, P, R*)
● Bakelite Co., A Div. of Union Carbide Corp., New York (*O, P, Q*)
●Barron, J. E. Plastics, Cincinnati (*B, C, G, H, J, K, L, O, P, Q, R*)
Blossom Mfg. Co., Inc., New York (*B, J, K*)
Blum Paul Co., Buffalo, N. Y. (*B, D*)
●Bolta Pdts. Div., General Tire & Rubber Co., Lawrence, Mass. (*P, Q*)
● Cadillac Plastic & Chemical Co., Detroit (*B, C, J, K, L, P*)
Canadian General-Tower Ltd., Galt, Ontario, Canada (*P, Q*)
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada (*K, P, Q*)
Canton Containers, Canton, Ohio (*K*)
Cee-Jay Extruders, Inc., New Hyde Park, N. Y. (*K*)
● Celanese Corp. of America, Newark, N. J. (*B*)
● Chicago Molded Products Corp., Chicago (*B, C, G, K, L*)
Chippewa Plastics, Inc., Chippewa Falls, Wis. (*K*)
Clopay Corp., Extruded Film Div., Cincinnati (*P*)
● Colonial Kolonite Co., Chicago (*J*)
Columbus Coated Fabrics Corp., Columbus, Ohio (*P, Q, R*)
Continental Can Co. Inc., Shellmar-Betner Div., Mt. Vernon, Ohio (*A, B, C, K*)
● Continental-Diamond Fibre Corp., Newark, Del. (*H*)
● Contour Extrusion Co., Mamaroneck, N. Y. (*K*)
Crane Packing Co., Morton Grove, Ill. (*H*)
Crystal-X Corp., Lenni Mills, Pa. (*K, L*)
● Davis, Joseph Plastics Co., Arlington, N. J. (*B, C, D, G, K, L, M, P, Q*)
Deerfield Plastics Co., Inc., South Deerfield, Mass. (*K*)
Dielect Inc., Fords, N. J. (*H, K, L*)
● Dow Chemical Co., Midland, Mich. (*G, L, R, S*)
● Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany (*B, D, K, L, P*)
● du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del, (*A, B*)
● Eastman Kodak Co., Cellulose Products Div., Rochester, N. Y. (*B, C, F*)
Electro-Technical Products, Nutley, N. J. (*P*)
Ellay Rubber Co., Los Angeles (*L, P*)
Elm Coated Fabrics Co., Inc., N. Y. C. (*P, Q*)
Extruders, Inc., Hawthorne, Calif. (*K*)
Extrudofilm Corp., Long Island City, N. Y. (*K*)
Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio (*H*)
Farbwerke Hoechst A.G., vormals Meister Lucius & Bruning, Flm.-Hoechst, Germany (*O*)
Federal Industries, Belleville, N. J. (*P*)
Ferplex Chemicals, Inc., New York (*B, D, P*)
● Firestone Plastics Co., Pottstown, Pa. (*K, P*)
Form-A-Lite, Inc., Northbridge, Mass. (*M, P, Q*)
● Foster, Grant Co., Inc., Petrochemical Div., Leominster, Mass. (*B, J, K, L*)
Garlock Packing Co., Palmyra, N. Y. (*H*)
General Dispersions Inc., Paterson, N. J. (*J*)
● General Tire & Rubber Co., Toledo Ohio (*M, P, Q*)
● General Tire & Rubber Co., The, Akron, Ohio (*P*)
● Gering Products, Inc., Kenilworth, N. J. (*K*)
Goodrich, B. F., Industrial Products Co., Marietta, Ohio (*P*)
Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*K, O, P, Q, R, S*)
Gusmer, A., Inc., Stalpic Div., Woodbridge, N. J. (*H*)
●H & R Industries, Nazareth, Pa. (*J, K*)
Industrial Sales Engineers, New York (*C, K, L*)
● Koppers Co., Inc., Pittsburgh, Pa. (*K*)
Labelon Tape Co., Inc., Rochester, N. Y. (*B*)
● Lamex Chemical Corp., Manchester, N. H. (*J, K, L*)
Linehan & Co., Dallas, Texas (*B, C*)
Lurie Plastics Inc., Colonial Hghts., Va. (*K, L*)
Micron Plastics Corp., Brooklyn, N. Y. (*K*)
● Midwest Plastic Products Co., Chicago Heights, Ill. (*B, CK*)
● Mono-Sol Corporation Gary, Ind. (*N, P*)
● Monsanto Chemical Co., Springfield, Mass. (*B, O, P*)
● Monsanto Kasei Chemical Co., Tokyo, Japan (*P*)
● Muehlstein, H., & Co., Inc., New York (*B, C, G, J, K, L, O, P, Q*)
● Naugatuck Chemical, Naugatuck, Conn. (*P*)
● Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*P*)
● Nixon Nitration Works, Nixon, N. J. (*B, C, D, K, P, Q*)
O'Sullivan Rubber Corp., Winchester, Virginia (*P*)
Pantasote Company, New York (*K, P, Q*)
Plaskolite, Inc., Columbus, Ohio (*B, C, G, L*)
Plastex Process Co., Maywood, N. J. (*J*)
Plastic Film Corp., Plainfield, Conn. (*K, P*)
Plastic Laminating Corp., Vaux Hall, N. J. (*B, Q*)
Plastofilm, Inc., Wheaton, Ill. (*B, C*)
Plax Corp., Hartford, Conn. (*J, L, K*)
Plicose Mfg. Corp., Bklyn., N. Y. (*K*)
Poly Plastic Products Inc., Paterson, N. J. (*K*)
Poly Cell Plastics Co., Smithtown, N. Y. (*K, L*)
● Polymer Corporation, Reading, Penn. (*H, J*)
● Polypenco, Inc., Reading, Penn. (*H, J*)
● Polyplastex United, Inc., Union, N. J. (*P*)
Protective Lining Corp., Brooklyn, N. Y. (*K, Q*)
P-V-A Industries, New York (*N, P*)
Ralston, W. & Co., Inc., Mt. Vernon, N. Y. (*K*)
● Raritan Industries, Paterson, N. J. (*K, L*)
Reliance Plastic & Chemical Corp., Paterson, N. J. (*K*)
Resincraft Plastics, Inc., Chicago (*P*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*P*)
● Respro Div., The General Tire & Rubber Co., (*P, Q, R*)
Reynolds Metals Co., Grottoes, Virginia (*N, P*)
● Rotuba Extruders, Inc., Brooklyn, N. Y. (*B, K, P*)
● Rubber Corp. of America, Hicksville, N. Y. (*P, Q*)
Rudd Plastic Fabrics Corp., Bklyn., N. Y. (*G, H, K, O, P, S*)
● Scranton Plastic Laminating Corp., Scranton, Pa. (*B, C, F, K, M, P, Q*)
● Seiberling Rubber Company, Newcomerstown, Ohio (*K, L, P, Q*)
Shore Line Industries, Clinton, Conn. (*K*)
Sommers Plastic Prod. Co., New York (*P*)
● Southern Plastic Co., Columbus, S. C. (*B, C, E, G, H, J, K, L, M, O, P, Q, S*)
Standard Pyroxoloid Corp., Leomiaster, Mass. (*B, D*)
Thalco, Los Angeles (*N*)
● Union Carbide International Co., New York (*Q*)
● United States Gasket Co., Camden, N. J. (*H*)
U.S. Stoneware Co., Akron, Ohio
● Waljohn Plastics Inc., Brooklyn, N. Y. (*P, Q*)

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

Westlake Plastics Company, Lenni Mills, Pa. (*H, K, L*)
Worbla Ltd. nr. Berne, Switzerland (*B, D, P, Q*)

FOAMED PLASTICS

(See Expanded Plastics)

GLASS, FIBROUS FOR REINFORCEMENT

For related editorial information see Laminates Chart P. 586 and the Low Pressure Resins Chart, p. 590, also p. 472

A. Impregnators and Coaters
B. Manufacturers
C. Weavers

American Combining Corporation, Rockaway Beach, Queens, N. Y. (*A*)
Bean, D. D. & Sons Co., Fiber Glass Div., Jaffrey, N. H. (*C*)
•Coast Mfg. & Supply Co., Livermore, Calif. (*A, C*)
Electro-Technical Products, Nutley, N. J. (*A*)
•Endura Corp., Quakertown, Pa. (*A*)
Everlite Corp., Seattle, Wash. (*A*)
•Exeter Mfg. Co., New York (*B, C*)
•Fabricon Products, A Div. of the Eagle-Picher Co., River Rouge, Mich. (*A*)
Famco, Inc., Louisville, Ky. (*B*)
•Ferro Corp., Fiber Glass Div., Nashville, Tenn. (*B, C*)
Flexfirm Products, El Monte, Calif. (*A*)
•Flightex Fabrics, Inc., New York (*C*)
L.O.F. Glass Fibers Co., Toledo, Ohio (*A*)
Melamine Plastics Inc., Winona, Minn. (*C*)
Mica Corporation, Culver City, Calif. (*B*)
Minnesota Mining & Mfg. Co., St. Paul, Minn. (*A*)
•Modigliani Glass Fibers Inc., New York (*B*)
•Pittsburgh Plate Glass Co., Pgh., Pa. (*B*)
•Polyplastex United, Inc., Union, N. J. (*A*)
•Riegel Paper Corp., New York (*A, B*)
•Sandman, Eli Co., Worcester, Mass. (*A, B, C*)
•Standard Insulation Co., East Rutherford, N. J. (*A*)
Stevens, J. P. & Co., Inc., New York (*C*)
Texas Glass Fiber Corp., Grandview, Tex. (*B*)

GLASS, RESIN LOADED FOR MOLDING

For related editorial information see the Laminates Chart, p. 586 and the Low Pressure Resins Chart, p. 590, also p. 472

Atlas Powder Co., Wilmington, Del.
Coast Mfg. & Supply Co., Livermore, Calif.
Electro-Technical Products, Nutley, N. J.
Fabricon Products, A Div. of the Eagle-Picher Co., River Rouge, Mich.
•Fiberfil, Inc., Warsaw, Ind.
•Fiberite, The, Corp., Winona, Minn.
Flexfirm Products, El Monte, Calif.
Haveg Industries, Inc., Wilmington, Del.
International Textile Co., Chicago, Ill.
Microcell Ltd., London, W.C.I., England
•Modigliani Glass Fibers Inc., New York
•Pittsburgh Plate Glass Co., Pgh., Pa.
•Plastic Molders Supply Co., Inc., Fanwood, N. J.
•Standard Insulation Co., East Rutherford, N. J.

GLUES

(See Adhesives)

JOBBERS

(Materials available from stock for immediate delivery)

•Bamberger, A., Corp., Brooklyn, N. Y.
•Barron, Jr. E. Plastics, Inc., Cincinnati, Ohio
•Cadillac Plastic Co., Detroit
•Commercial Plastics & Supply Corp., New York
•Davis, Jos. Plastics Co., Arlington, N. J.
•Gering Products, Inc., Kenilworth, N. J.
Henriques, J. B., Inc., New York
Interplastics Corp., N. Y.
•Muehlstein, H. & Co., New York
Toepfer, Alfred, New York
•Transilwrap Company, Chicago

LAMINATES

(See also Laminators and Reinforced Plastics)

For related editorial information see the Laminates Chart, p. 586 and the Low Pressure Resins Chart, p. 590 also p. 506

Airconductors, Compton, Calif.
Atlas Plastics, Inc., Buffalo, N. Y.
Biggs, Carl H. Co., Inc., Los Angeles
Chemtron Fiber Glass Co., El Monte, Calif.
•Continental-Diamond Fibre Corp., Newark, Del.
•Davis, Joseph Plastics Co., Arlington, N. J.
•Decar Plastic Corp., Middleton, Wis.
du Verre, Inc., Buffalo, N. Y.
Everlite Corp., Seattle, Wash.
Flexfirm Products, El Monte, Calif.
Form-A-Lite, Inc., Northbridge, Mass.
Franklin Fibre-Lamitex Corp., Wilmington, Del.
Garlock Packing Co., Palmyra, N. Y.
Gill, M. C., Corp., El Monte, Calif.
Harstil Industries Co., St. Clair Shore, Mich.
Johns-Manville, New York
McMillan Industrial Corp., Ipswich, Mass.
Mica Corporation, Culver City, Calif.
•Microcell, Ltd., London, W.C.I., England
Minnesota Mining & Mfg. Co., St. Paul, Minn.
•National Plastic Prod. Co., Odenton, Mo.
•National Vulcanized Fibre Co., Wilmington, Del.
•New England Laminates Co., Stamford, Conn.
•Polyplastex United, Inc., Union, N. J.
Ren Plastics Inc., Lansing, Mich.
Schori Process Division of Ferro-Co. Corp., New York
•Scranton Plastic Laminating Corp., Scranton, Pa.
Spaulding Fibre Co., Inc., Tonawanda, N. Y.
•Swedlow Plastics Co., Youngstown, Ohio
Synthane Corp., Oake, Penna.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Electric Corp., Micarta Div., Hampton, S. C.

LATEX, RESIN

(See Emulsions and Dispersions)

B. B. Chemical Co., Cambridge, Mass.
•Bakelite Co., A Div. of Union Carbide Corp., New York
Borden Co., Chemical Div., New York
•Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass.
•Firestone Plastics Co., Pottstown, Pa.
•Goodrich, B. F. Co., Industrial Products Div., Akron, Ohio
•Goodyear Tire & Rubber Co., Akron, Ohio
•Monsanto Chemical Co., Springfield, Mass.
•Naugatuck Chemical, Naugatuck, Conn.
•Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn.
Paisley Products Inc., New York
Polymer Chemical Co., Cincinnati, Ohio
U B S Chemical Corp., Cambridge, Mass.

LOW PRESSURE LAMINATING RESINS

•American Cyanamid Co., New York
Atlas Powder Co., Wilmington, Del.
•Bakelite Co., A Div. of Union Carbide Corp., New York
Chemical Development Corp., Danvers, Mass.
•Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N. Y.
Electro-Technical Products, Nutley, N. J.
Interchemical Corp., Finishes Div., Newark, N. J.
Ironsides Resins, Inc., Columbus, Ohio
Mol-Rez Division-American Petrochemical Corp., Minneapolis, Minn.
•Naugatuck Chemical, Naugatuck, Conn.
Ren Plastics Inc., Lansing, Mich.
•Rohm & Haas Co., Philadelphia, Pa.

LUMINESCENT PLASTICS

American Combining Corp., Rockaway Beach, Queens, N. Y.
•American Molding Powder & Chemical Corp., Brooklyn, N. Y.
•Cadillac Plastic & Chemical Co., Detroit
•Interplastics Corp., New York
•Luminous Resins Inc., Chicago, Ill.
•Plastics Color Co., Chatham, N. J.

MOLDING AND LAMINATING BOARDS AND BLANKS

For related editorial information see the Laminates Chart, p. 586 and the Low Pressure Resins Chart, p. 590 also p. 506

•Chemische Werke Huls A.G., Marl, W. Germany
•Continental-Diamond Fiber Corp., Newark, Del.
•Fiberite, The, Corp., Winona, Minn.
Flexfirm Products, El Monte, Calif.
Form-A-Lite, Inc., Northbridge, Mass.

•Indicates Advertiser.

Lee, Walter Corp., Bronx, N. Y.
● Rogers Corporation, Rogers, Conn.
Rudd Plastic Fabrics Corp., Bklyn, N. Y.
Westinghouse Electric Corp., Micarta Div., Hampton, S. C.

MOLDING COMPOUNDS, MANUFACTURERS OF

For related editorial information see the Plastics Properties Chart, also p. 86

A. *Acrylate and Methacrylate*
B. *Alkyd*
C. *Cellulose Acetate*
D. *Cellulose Acetate Butyrate*
E. *Cellulose Propionate*
F. *Cold Molded*
G. *Diallyl Phthalate*
H. *Epoxy*
I. *Ethyl Cellulose*
J. *Fluorocarbons (Halogenated Ethylenes)*
K. *Furan*
L. *Melamine-Formaldehyde*
M. *Nylon (Polyamide)*
N. *Phenolic*
O. *Polyethylene*
P. *Shellac*
Q. *Silicone*
R. *Styrene*
S. *Styrene Copolymers*
T. *Urea-Formaldehyde*
U. *Vinyl Acetal*
V. *Vinyl Acetate*
W. *Vinyl Alcohol*
X. *Vinyl Chloride*
Y. *Vinyl Chloride Acetate*
Z. *Vinyl Chloride-Vinylidene Chloride*
AA. *Vinyl Formal*
BB. *Vinylidene Chloride*
CC. *Premix-Glass Polyester*

Acco Polymers, New York (*A*)
● Acme Resin Corporation, Forest Pk., Ill. (*G*)
● Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., New York (*O*)
Amco Plastic Materials, Inc., Brooklyn, N. Y. (*A, C, I, M, O, R, S, X*)
● American Cyanamid Co., New York (*L, R, T*)
● American Cyanamid Co., Plastic & Resin Div., New York (*L, T*)
● American Molding Powder & Chemical Corporation, Brooklyn, N. Y. (*A, C, I, O, R, S, X, M*)
American Viscose Corp., Philadelphia, Pa. (*T*)
● Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio (*B*)
Argo Plastic Products, Cleveland (*O*)
Aries Laboratories, Inc., Long Island City, N. Y. (*H*)
Atlas Powder Co., Wilmington, Del.
● Auburn Button Works, Inc., Auburn, N. Y. (*X*)
BX Plastics Ltd., London, England (*C, R, S, X, Z*)
B.I.P. Chemicals Limited, Nr. Birmingham, England (*B, L, T*)
● Badische Anilin & Soda Fabrik A.G., Ludroigshafen Rhein, Germany (*M, R, S*)
● Bakelite Co., A Div. of Union Carbide Corp., New York (*H, J, N, O, R, S, X, Y*)
Bamberger, Claude P. Inc., Ridgefield, N. J. (*A, C, I, M, O, R, S*)
● Belding Corticelli Industries, New York (*M*)
Biggs, Carl H. Co., Inc., Los Angeles (*H*)
Blum, Paul Co., Buffalo, N. Y. (*A, C, M, O, R, X*)
Booty Resineers, Inc., Newark, Ohio (*H*)
● Cadillac Plastic & Chemical Co., Detroit (*H, S*)
● Catalin Corp. of America, N. Y. (*L, N, P, Q*)
● Celanese Corp. of America, Newark, N. J. (*C, E, O*)
● Chemische Werke Huls A.G., Marl, W. Germany (*R, X, BB*)
Chemtron Fiber Glass Co., El Monte, Calif. (*H*)
● Colonial Kolonite Co., Chicago (*C*)
Colton Chemical Co., A Div. of Air Reduction Co., Inc., Cleveland (*W*)
Crane Packing Co., Morton Grove, Ill. (*J*)
● Davis, Joseph Plastics Co., Arlington, N. J. (*C, I, O, R, S, V, X, Y*)
● Decar Plastic Corp., Middleton, Wis. (*L, N*)
● Dow Chemical Co., Midland, Mich. (*I, O, R, S, X, Z, BB*)
Dow Corning Corp., Midland, Mich. (*Q*)
Dreyfus, L. A., Co., So. Plainfield, N. J. (*O*)
● du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*A, M, O*)
● Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany (*C, I, L, N, R, T, X*)
● Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N. Y. (*G, N*)
● Eastman Chemical Products, Inc., Kingsport, Tenn. (*C, D, O*)
Elastomer Chemical Corp., Newark, N. J. (*X, Y*)
Ellay Rubber Co., Los Angeles (*X*)
Emerson & Cuming, Inc., Canton, Mass. (*H*)
Everlite Corp., Seattle, Wash. (*S*)
● Fiberfil, Inc., Warsaw, Ind. (*M, O, R, S*)
● Fiberite, The, Corp., Winona, Minn. (*L, N*)
● Firestone Plastics Co., Pottstown, Pa. (*X*)
Flexfirm Products, El Monte, Calif. (*G, H, S*)
● Furane Plastics Inc., Los Angeles (*H*)
Garfield Manufacturing Co., Garfield, N. J. (*F*)
● General Electric Co., Chemical & Materials Dept., Pittsfield, Mass. (*N*)
● Gering Products, Inc., Kenilworth, N. J. (*A, C, M, O, R, S, X, Y, Z*)
Glaskyd Inc., Perrysburgh, Ohio (*B*)
● Goodrich, B. F. Chemical Co., Cleveland, Ohio (*W, Z*)
Gordon Chemicals, Inc., Wilmington, Del (*T*)
Haveg Industries, Inc., Wilmington, Del (*K, N*)
Hercules Powder Co., Inc., Wilmington, Del. (*C, I, O*)
Houghton Laboratories, Inc., Olean, N. Y. (*H*)
● Imperial Chemical Industries Ltd., Plastics Div., Hertfordshire, Eng. (*A, O, X*)
International Textile Co., Chicago, Ill. (*L, N*)
● Interplastics Corp., New York (*A, C, I, O, R, S, X*)
Kellogg, M. W. Co., Jersey City, N. J. (*J*)
● Koppers Co., Inc., Pittsburgh, Pa. (*R*)
Lacrinoid Products Ltd., County Essex, Eng. (*T*)
● Marbon Chemical Div., Borg-Warner Corp., Gary, Ind. (*S*)
Melamine Plastics Inc., Winona, Minn. (*L*)
Meriden Molded Plastics Inc., Meriden, Conn. (*F*)
Mesa Plastics Co., Los Angeles (*G, Q*)
● Microcell, Ltd., Low Dow, England (*N*)
● Monsanto Chemical Co., Springfield, Mass. (*N, O, R, X*)
● Muehlstein, H., & Co., Inc., New York (*O, R, S, X, Z*)
● National Vulcanized Fibre Co., Wilmington, Del. (*H, L, M, N, Q*)
● Naugatuck Chemical, Naugatuck, Conn. (*X*)
● Naugatuck Chem. U.S. Rubber Co., Naugatuck, Conn. (*B, S, X, CC*)
● Ohio Apex Div. F.M.C., Nitro, W. Va. (*G*)
O'Sullivan Rubber Corp., Winchester, Virginia (*S*)
Pelron Corporation, Lyons, Ill. (*G*)
● Peters Chemical Mfg. Co., Melrose Park, Ill. (*A*)
Pitt-Consol Chemical Company, Newark, N. J. (*N*)
Plastic Materials Inc. Hicksville, N. Y. (*A, C, O, R*)
● Plastics Engineering Co., Sheboygan, Wis. (*N*)
Plumb Chemical Corp., Philadelphia, Penna.
Premier Thermo Plastics Co., Jeffersontown, Ky., (*X, Y*)
Raybestos Manhattan Inc., Manheim, Pa. (*N, Q*)
Ren Plastics Inc., Lansing, Mich. (*H*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*X*)
● Reynolds Chemical Products Co., Ann Arbor, Mich. (*Y*)
Riverdale Plastics & Chem. Corp., Culver City, Calif. (*N, O*)
● Rogers Corporation, Rogers, Conn. (*N*)
● Rohm & Haas Co., Philadelphia, Pa. (*A*)
● Rotuba Extruders Inc., Brooklyn, N. Y. (*C, X, Y*)
● Rubber Corp. of America, Hicksville, N. Y. (*X*)
Rudd Plastic Fabrics Corp., Bklyn., N. Y. (*J, Q, S, X*)
S. A. Solvic, Bruxelles, Belgique (*X, Y*)
● Stanley Chemical Co., East Berlin, Conn. (*H, X, Y*)
Synvar Corporation, Wilmington, Del. (*N*)
● U. S. Industrial Chemicals Co. Div. of National Distillers & Chemical Corp. (*O*)
● Valite Div. Valentine Sugars, Inc., New Orleans, La. (*N*)
● Waljohn Plastics Inc., Brooklyn, N. Y. (*X*)
Williamson Adhesives, Inc., Skokie, Ill. (*S*)
Yates Company, Erie, Pa. (*X*)

MONOFILAMENTS

(See Fibers and Filaments, Synthetic)

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

MONOMERS

For related editorial information see p. 86

A. *Acrylate and Methacrylate*
B. *Allyl*
C. *Alpha Methyl Styrene*
D. *Butadiene*
E. *Divinylbenzene*
F. *Styrene*
G. *Vinyl Acetate*
H. *Vinyl Carbozole*
I. *Vinyl Chloride*
J. *Vinyl Ethers*
K. *Vinylidene Chloride*

Acco Polymers, New York (*A*)
Air Reduction Chemical Co., New York (*G*)
●American Cyanamid Co. Organic & Pigments Div., New York (*I*)
●Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York (*H*)
Anorgana G.M.B.H., New York (*I*)
●Barrett Div., Allied Chemical & Dye Corp., New York (*C*)
●Bolta Pdts. Div., General Tire & Rubber Co., Lawrence, Mass. (*I, K*)
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada (*I*)
●Carbide & Chemicals Co., New York (*A, D, F, G*)
Chemical Development Corp., Danvers, Mass. (*A*)
●Chemische Werke Huls A.G., Marl, W. Germany (*D, F, I, K*)
Columbia-Southern Chemical Corp., Pittsburgh, Pa. (*B*)
●Dow Chemical Co., Midland, Mich. (*C, E, F, I, K*)
●du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*A, G*)
●Foster Grant, Co., Inc., Petrochemical Div., Leominster, Mass. (*F*)
●Imperial Chemical Industries Ltd., Plastics Div., Hertfordshire, Eng. (*A, I*)
●Koppers, Co., Inc., Pittsburgh, Pa. (*E, F*)
●Monsanto Chemical Co., Springfield, Mass. (*F*)
●Naugatuck Chemical, Naugatuck, Conn. (*I*)
●Ohio Apex Div. F. M. Nitro, W. Va., (*B*)
●Peters Chemical Mfg. Co., Melrose Park, Ill. (*A*)
Petro Tex Chemical Corp., Houston, Texas (*D*)
●Rohm & Haas Co., Philadelphia, Pa. (*A*)
Specialty Resins, Inc., Chicago (*B*)
Thalco, Los Angeles, (*F*)
U. S. Plastic Products Corp., Metuchen, N. J. (*A*)

ORGANOSOLS AND PLASTISOLS

For related editorial information see p. 175

A. *Organosols*
B. *Plastisols*

●American Molding Powder & Chemical Corp., Brooklyn, N. Y. (*B*)
Associated Rubber & Plastic Corp. New York (*B*)
●Atlas Coatings Corp., Long Island City, N. Y. (*A, B*)
Atlas Mineral Products Co., Mertztown, Pa. (*B*)
●Auburn Button Works, Inc., Auburn, N. Y. (*A, B*)
Borden Co., Chemical Div., New York (*A, B*)
Chemedical Research Associates, Upper Darby, Penna. (*A, B*)
Chemical Development Corp., Danvers, Mass. (*A, B*)
●Chemical Products Corp., East Providence, R. I. (*A, B*)
●Chemische Werke Huls A.G., Marl, W. Germany (*B*)
Columbus Coated Fabrics Corp., Columbus, Ohio (*A, B*)
●Cordo Chemical Corp., Norwalk, Conn. (*A, B*)
Crest Chemical Industries Corp., Brooklyn, N. Y. (*B*)
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass. (*B*)
Elastomer Chemical Corp., Newark, N. J. (*A, B*)
Electro-Technical Products, Nutley, N. J. (*A, B*)
Farrington Texol Corp., Walpole, Mass. (*A, B*)
Federal Chemicals Corp., Brooklyn, N. Y. (*A, B*)
Federal Latex Corp., Brooklyn, N. Y. (*B*)
●Firestone Plastics Co., Pottstown, Pa. (*B*)
Flexible Products Co., Marietta, Ga. (*A, B*)
Foam King, Inc., Bronx, N. Y. (*B*)
General Plastics Mfg. Co., Tacoma, Wash. (*B*)
Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*A, B*)
●Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co., Akron, Ohio, (*A, B*)
Industrial Sales Engineers, New York (*A, B*)
●Industrial Solvents & Chemicals, Inc., Wilkinsonville, Mass. (*A, B*)
Interchemical Corp., Finishes Div., Newark, N. J. (*A, B*)
International Plastic Co., New York (*B*)
Jamestown Finishes, Inc., Jamestown, N. Y. (*A, B*)
L & P Tool Company, Cincinati, Ohio (*B*)
●Logo, Inc., Chicago, Ill. (*A, B*)
Magic Chemical Co., Brockton, Mass. (*A, B*)
●Metal & Thermit Corp., Rahway, N. J. (*A, B*)
●Michigan Chrome & Chemical Co., Detroit (*B*)
Midland Adhesive & Chemical Corp., Ferndale, Mich. (*A, B*)
●Muehlstein, H. & Co., Inc., New York (*B*)
Navarm Chemical Co., Maywood, Calif. (*A, B*)
Parcloid Chemical Co., Midland Park, N. J. (*A, B*)
Poly Resins, Sun Valley, Calif. (*A, B*)
Polykote, Inc., Cleveland Ohio (*B*)
Polymer Chemical Co., Cincinnati, Ohio (*B*)
Protective Treatments, Inc., Dayton, Ohio (*A, B*)
Pyroxylin Products, Inc., Chicago (*A, B*)
●Reynolds Chemical Co., Ann Arbor, Mich. (*A, B*)
●Rubber Corporation of America, Hicksville, N. Y. (*A, B*)
Seal Peel Inc., Royal Oak, Mich. (*A, B*)
Shasta Manufacturing Inc., Akron, Ohio (*B*)
Sherwin Williams Co., New York (*A, B*)
●Stanley Chemical Co., East Berlin, Conn. (*A, B*)
●Sullivan Varnish Co., Chicago (*A, B*)
Technicraft Co., Boston, Mass. (*B*)
U.S. Stoneware Co., Akron, Ohio (*B*)
Vacuum Coatings, Inc., Wilkinsonville, Mass. (*A, B*)
●Watson-Standard Company, Pitts., Pa. (*A, B*)
Western Coating Co., Royal Oak, Mich. (*A, B*)
Wilross Products Co., Hawthorne, N. J. (*A, B*)

PAPER, RESIN IMPREGNATED OR COATED

●Bakelite Co., A Div. of Union Carbide Corp., New York
Clopay Corp., Extruded Film Div., Cincinnati, Ohio
Columbus Coated Fabrics Corp., Columbus, Ohio
●Decar Plastic Corp., Middletown, Wis.
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass.
Electro-Technical Products, Nutley, N. J.
Farrington Texol Corp., Walpole, Mass.
●Fabricon Products, A Div. of The Eagle-Picher Co., River Rouge, Mich.
Johns-Manville, New York
Paper Products Development, New York
Plastic Film Corp., Plainfield, Conn.
●Respro Division, The General Tire & Rubber Co., Cranston, R. I.
●Riegel Paper Corp., New York
●Sandman, Eli Co., Worcester, Mass.
Sorg Paper Co., Middletown, Ohio
●Standard Insulation Co., East Rutherford, N. J.

PAPER FOR RESIN IMPREGNATING

(Including High Tensile)

For related editorial information see the Laminates Chart, p. 598 also p. 506

American Combining Corp., Rockaway Beach Queens, N. Y.
●Brown Co., Boston, Mass.
Buckeye Cellulose Corp., Memphis, Tenn.
●Hurlbut Paper Co., South Lee, Mass.
Johns-Manville, New York
Paper Products Development, New York
●Mosinee Paper Mills Co., Mosinee, Wis.
Paterson Parchment Paper Company, Bristol, Penn.
●Riegel Paper Corp., New York
●Sandman, Eli Co., Worcester, Mass.
Sorg Paper Co., Middletown, Ohio
●Wrenn Paper Co., Middletown, Ohio

PAPER, PRINTED, FOR LAMINATING

For related editorial information see the Laminates Chart, p. 598 also p. 506

Decotone Products Div., Fitchburg, Mass.
Dexter, C. H. & Sons, Inc., Windsor Locks, Conn.
Johns-Manville, New York
●Morart Gravure Corporation, Holyoke, Mass.
Paper Products Development, New York

●Indicates Advertiser.

PEARL ESSENCE

- Claremont Pigment Dispersion Corp., Roslyn Hghts., New York
- Logo, Inc., Chicago, Ill.
- Mearl Corp., New York

Plastic Materials Inc., Hicksville, N. Y.

- Riverdale Color Co., Inc., Newark, N. J.

Taussig, F. H., New York

PHOTOELASTIC PLASTICS

(For Laboratory Work)

Applied Plastics, Co., Inc., El Segundo, Calif.

- Catalin Corp. of America, New York

Houghton Laboratories, Inc., Olean, N. Y.

PIGMENTS, INORGANIC

(See also Dyes)

For related editorial information see p. 367

- American Cyanamid Co., Organic & Pigments Div., New York
- American Cyanamid Co., Adhesives, Resins and Chemicals Div., New York
- American Molding Powder & Chemical Corporation, Brooklyn, N. Y.
- Claremont Pigment Dispersion Corp., Roslyn Hghts., New York
- Columbian Carbon Co., New York

Doggett, Stanley Inc., New York

- du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
- Eagle-Picher Co., The, Cincinnati, Ohio
- Ferro Corp., Plastic Color Div., Cleveland

General Color Co., Newark, N. J.

- General Dyestuff Co., Sales Div. of General Aniline & Film Corp., New York
- Harshaw Chemical Co., Cleveland
- Harwick Standard Chemical Co., Akron, Ohio
- Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
- Mapico Color Unit, Columbian Carbon Co., New York

New Jersey Zinc Co., New York

Osborn, C. J. Company, Linden, N. J.

- Plastics Color Co., Chatham, N. J.

Sherwin Williams Co., New York

Titanium Pigment Corp., New York

PIGMENTS, LUMINESCENT

- American Molding Powder & Chemical Corporation, Brooklyn, N. Y.

Doggett, Stanley Inc., New York

- de Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
- Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
- Luminous Resins Inc., Chicago, Ill.
- Plastics Color Co., Chatham, N. J.

PIGMENTS, METALLIC

Aluminum Co. of America, Pittsburgh, Pa.

- Metals Disintegrating Co., Inc., Elizabeth, N. J.

Reynolds Metals Co., Louisville, Ky.

PITCHES AND TAR BASES

- Barrett Div., Allied Chemical & Dye Corp., New York

PLASTICIZERS

For related editorial information see the Plasticizers Chart p. 598 also p. 364

A. *Abietates*
B. *Adipates*
C. *Biphenyls*
D. *Camphor*
E. *Citrates*
F. *Glycerol and Glycol Compounds*
G. *Glycolates*
H. *Hydrocarbons*
I. *Laurates*
J. *Levulinates*
K. *Oleates*
L. *Phosphates*
M. *Phthalates*
N. *Polyester*
O. *Ricinoleates*
P. *Sebacates*
Q. *Stearates*
R. *Succinates*
S. *Synthetic Rubber*
T. *Sulfonamide*
U. *Toluenesulfonamides*
V. *Secondary*

Adhesive Products Corporation, New York (*S*)

- Advance Solvents & Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, N. J. (*B, F, G, I, K, O, Q, S*)

Alkydol Laboratories, Inc., Cicero, Ill. (*B, M, N, O, P*)

Amoco Chemicals Corp., Chicago (*H, V*)

- Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York (*N*)
- Archer-Daniels-Midland Co., Newark, N. J. (*B, F, K, M, N, P, V*)
- Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio (*F, N*)
- Argus Chemical Corp., Brooklyn, New York (*I, J, K, Q, V*)

Atlas Powder Co., Wilmington, Del. (*F*)

- Badische Anilin & Soda Fabrik A.G., Ludroigshafen Rhein, Germany (*B, F, M, N*)

Baker Castor Oil Co., Bayonne, N. J. (*O, Q, V*)

- Barrett Div., Allied Chemical & Dye Corp., New York (*B, M, N, V*)
- Cabot, Godfrey L. Inc., Boston, Mass. (*B, L, M*)

Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada (*B, M, P*)

- Carbide & Chemicals Co., New York (*B, C, F, L, M, N*)

Carlisle Chemical Works, Inc., Reading, Ohio (*F, G, I, K, O, Q*)

Cary Chemical Co., New Brunswick, N. J. (*B, M, P*)

- Celanese Corp. of America, Chemical Div., N. Y. (*L, M*)
- Chemische Werke Huls A.G., Marl, Germany (*M, N, S*)
- Columbian Carbon Co., New York (*B, M, P, Q*)
- Diamond Alkali Co., Chlorowax Div., Cleveland (*V*)
- Deecy Products Co., Cambridge, Mass. (*B, I, M, O, P, Q, V*)
- Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass. (*B, M, P, S*)
- Dow Chemical Co., Midland, Mich. (*V*)
- du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*D, L, Q, S*)
- Eastman Chemical Products, Inc., Kingsport, Tenn. (*B, F, L, M, N, P*)
- Emery Industries, Inc., Cincinnati, Ohio (*K, N, S, V*)

Foremost Food & Chemical Co., El Dorado Div., Oakland, Calif. (*F*)

Glyco Products Co., Inc., New York (*I, K, O, Q*)

- Goodrich, B. F., Chemical Co., Cleveland, Ohio (*B, M, S*)

Gordon-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*M*)

Greeff, R. W., & Co., Inc., New York (*F, M, Q, T*)

- Harwick Standard Chemical Co., Akron, Ohio (*B, I, K, M, P, Q*)

Hercules Powder Co., Inc., Wilmington, Del. (*A, M, V*)

- Hommel, O. Co., The, Pittsburgh (*Q*)

Howards & Sons (Canada) Ltd., Montreal, Ontario, Canada (*M*)

Kay Fries Chemicals, Inc., American British Chemical Supplies, Inc., New York (*M*)

Kenrich Corp., Maspeth, N. Y. (*H*)

Kessler Chemical Co., Inc., Philadelphia, Pa. (*B, F, I, K, M, Q, V*)

Kolker Chemical Corp., Newark, N. J. (*B, G, L, M, N, P, Q, V*)

Mallinckrodt Chemical Works, St. Louis, Mo. (*Q*)

- Monsanto Kasei Chemical Co., Tokyo, Japan (*B, M*)

Montrose Chemical Co., Newark, N. J. (*L, M, U*)

Morton Withers Chemical Co., Greensboro, N. C. (*B, F, I, K, M, N, P, Q*)

- Naugatuck Chemical, Naugatuck, Conn. (*A, B, L, M, P. S. V*)
- Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*B, L, M, P*)

Neville Chemical Co., Pittsburgh (*S, V*)

- Ohio Apex Div. F.M.C. Nitro, W. Va., (*B, K, L, M, O, Q, S*)

Pennsylvania Industrial Chemical Corp., Clairton, Penna. (*H, V*)

Pennsylvania Salt Mfg. Co., Philadelphia, Penna. (*H*)

- Pittsburgh Coke & Chemical, Pittsburgh (*B, K, L, M, P*)
- Reichhold Chemicals, Inc., White Plains, N. Y. (*B, M, P*)
- Rohm & Haas Co., Philadelphia, Pa. (*M, N, P*)
- Rubber Corporation of America, Hicksville, N. Y. (*B, F, K, M, N, P, Q, S, V*)

Sherwin Williams Co., New York (*M*)

- Synthetic Products Co., Cleveland (*A, I, O, Q*)

Thomtson Chem. Co., Pawtucket, R. I. (*B, M*)

- U. S. Industrial Chemical Co. Div. of National Distillers & Chemical Corp., New York (*M*)
- Wallace & Tiernan, Inc., Belleville, N. J. (*B, F, G, K, M, N, O, P*)
- Witco Chemical Co., New York (*B, K, M, Q*)

RESINS

For related editorial information see the Plastics Properties Chart; also p. 86

A. *Acrylate and Methacrylate*
B. *Alkyd*
C. *Allyl*
D. *Aniline-Formaldehyde*
E. *Cast Phenolic*
F. *Coumarone-Indene*
G. *Epoxy*
H. *Fluorocarbons*
I. *Furan*
J. *Glass Bonded Mica*
K. *Hydrocarbon (Petroleum)*
L. *Hydrocarbon (Terpene)*
M. *Ion Exchange*

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

N. *Isocyanates*
O. *Lignin*
P. *Lignite*
Q. *Melamine-Formaldehyde*
R. *Nylon (Polyamide)*
S. *Oil Soluble*
T. *Phenoloc*
U. *Plywood Bonding and Laminating*
V. *Polyamide*
W. *Polyester*
X. *Polyethylene*
Y. *Resorcinol-Aldehyde*
Z. *Silicone*
AA. *Sodium Carboxymethyl*
BB. *Styrene (Including Derivatives and Copolymers)*
CC. *Urea-Formaldehyde*
DD. *Varnish and Lacquer Making*
EE. *Vinyl Acetate*
FF. *Vinyl Alcohol*
GG. *Vinyl Butyral*
HH. *Vinyl Carbazole*
II. *Vinyl Chloride*
JJ. *Vinyl Chloride Acetate*
KK. *Vinyl Formal*
LL. *Vinyl Chloride-Vinylidene Chloride*
MM. *Vinylidene Chloride*
NN. *Water Soluble*

Acco Polymers, New York (*A*)
●Acme Resin Corporation, Forest Pk., Ill. (*C, E, H, T, U, NN*)
Alkydol Laboratories, Inc., Cicero, Ill. (*B, G, S, T, W, BB, DD, EE, NN*)
●Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., New York (*X*)
●Allied Chemical & Dye Corporation, National Aniline Div. New York (*R*)
Alpha Chemical & Plastics Corp., Newark, N. J.(*X, II*)
American Alkyd Industries, Carlstadt, N. J. (*B, W, BB, CC, DD*)
●American Cyanamid Co., Plastic & Resin Div. New York (*B, Q, U, W, CC, NN*)
●American Cyanamid Co., organic & pigments Div., New York (*II*)
●American Cyanamid Co., New York (*B, Q, U, W, BB, CC, NN*)
American-Marietta Co., Adhesive, Resin & Chemical Div., Seattle, Wash. (*T, U, Y, CC*)
●American Molding Powder & Chemical Corporation, Brooklyn, N. Y. (*II, JJ*)
Amoco Chemicals Corp., Chicago, (*K*)
●Anorgana G. M. B. H., Munchen, Germany (*II*)
●Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York (*HH*)
Applied Plastics Co., Inc., El Segundo, Calif. (*G, N*)
●Archer-Daniels-Midland Co., Chemical Prods. Div., Cleveland, Ohio (*B, W*)
●Archer-Daniels-Midland Co., Newark, N. J. (*B, E, N, S, T, W, BB, DD*)
Aries Laboratories, Inc., Long Island City, N. Y. (*G*)
Armitage, John L. & Co., Newark, N. J. (*DD*)
Armstrong Products Co., Warsaw, Ind. (*G*)
Atlas Mineral Products Co., Mertztown, Pa. (*J*)
Atlas Powder Co., Wilmington, Del. (*W*)
BX Plastics Ltd., London, England (*BB*)
B. B. Chemical Co., Cambridge, Mass. (*N*)
B.I.P. Chemicals Limited, Nr. Birmingham, England (*B, Q, W, CC, NN*)
●Badische Anilin & Soda Fabrik A. G., Ludroigshafen Rhein, Germany (*R, V, W, X, BB, CC, DD, HH, II, MM, NN*)
●Bakelite Co., A Div. of Union Carbide Corp., New York (*G, H, S, T, U, W, X, Y, Z, BB, DD, EE, GG, II, JJ, NN*)
Bamberger, Claude P. Inc., Ridgefield Park, N. J. (*A, II*)
●Barrett Div., Allied Chemical & Dye Corp., New York (*B, F, Q, R, T, U, W, BB, CC, DD, NN*)
●Belding Corticelli Industries, New York (*V*)
Blum Paul Co., Buffalo, N. Y. (*A*)
Booty Resineers, Inc., Newark, Ohio (*T, V, CC*)
Borden Co., Chemical Div., New York (*A, G, T, U, V, Y, BB, DD, EE, FF, GG, II, JJ, LL, MM, NN*)
Brea Chemicals, Inc., Los Angeles, Calif. (*X*)
British Geon Limited, London, W. 1., England (*II, JJ, LL*)
California Ink Co., Inc., San Francisco, Calif. (*N*)
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada (*GG, II, JJ*)
Cary Chemical Co., New Brunswick, N. J. (*II*)
●Catalin Corp. of America, N. Y. (*O, R, S, V, Y, Z, KK*)
●Celanese Corp. of America, Newark, N. J. (*W, EE*)
Chemical Development Corp., Danvers, Mass. (*A, G, DD, JJ*)
●Chemische Werke Huls A.G., Marl, W. Germany (*V, W, X, BB, DD, II, LL, MM*)
●Chemore Corp., New York (*II, JJ*)
●Ciba Co., Inc., New York (*D, G, V*)
Colton Chemical Co., A Div. of Air Reduction Co., Inc., Cleveland (*EE, FF*)
●Cordo Chemical Corp., Norwalk, Conn. (*G, W*)
●Diamond Alkali Co., Chlorowax Div., Cleveland (*II*)
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass. (*BB, EE*)
Doggett, Stanley Inc., New York (*P*)
●Dow Chemical Co., Midland, Mich. (*M, X, BB, II, LL, MM*)
Dow Corning Corp., Midland, Mich. (*Z*)
●Du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*A, R, V, X, EE, FF*)
●Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany (*E, J, T, U*)
●Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N. Y. (*I, S, T, W, DD, NN*)
●Eastman Chemical Products, Inc., Kingsport, Tenn. (*X, DD*)
Electronic Mechanics, Inc., Clifton, N. J. (*J*)
Emerson & Cuming, Inc., Canton, Mass. (*G, W*)
Epoxylite, The, Corp., El Monte, Calif. (*G*)
●Escambia Chemical Corp., New York (*II*)
Farbwerke Hoechst A.G., vormals Meister Lucius & Brüning, Ffm Hoechst, Germany (*H, X, EE, FF, GG, YY, KK*)
●Firestone Plastics Co., Pottstown, Pa. (*II*)
●Foster Grant Co., Inc., Petrochemical Div., Leominster, Mass. (*R, BB*)
France, Campbell & Darling, Inc., Kenilworth, N. J.
McCloskey Varnish Co., Philadelphia
●Furane Plastics Inc., Los Angeles (*G, I*)
Gem City Trading, Dayton, Ohio (*X, BB*)
●General Electric Co., Chemical & Materials Dept., Pittsfield, Mass. (*T*)
General Mills, Inc., Kankakee, Ill. (*V*)
●General Tire & Rubber Co., Chemical Div., Akron, Ohio (*W, II, JJ*)
●Gering Products, Inc., Kenilworth, N. J. (*A, R, X, BB, II, JJ*)
●Glidden Co., Cleveland (*B, W, DD*)
●Goodrich, B. F. Chemical Co., Cleveland, Ohio (*BB, II, LL*)
●Goodyear Tire & Rubber Co., The, Chemical Div., Akron, Ohio (*BB, II*)
●Grace, W. R. & Co., Polymer Chemicals Div., Clifton, N. J. (*X*)
●Great American Plastics Co., Nashua, N. H. (*II*)
Greeff, R. W., & Co., New York (*M*)
●Harwick Standard Chemical Co., Akron, Ohio (*F, K, L*)
Haveg Industries, Inc., Wilmington, Del. (*D, E, I, S, T*)
Hercules Powder Co., Inc., Wilmington, Del. (*B, X, DD*)
Heresite & Chemical Co., Manitowoc, Wis. (*S, T, DD*)
●Hommel, O. Co., The, Pittsburgh (*T*)
Houghton Laboratories, Inc., Olean, N. Y. (*G, N*)
●Imperial Chemical Industries Ltd., Plastics Div., Hertfordshire, Eng. (*A, R, T, V, X, CC, II*)
Interchemical Corp., Finishes Div., Newark, N. J. (*W*)
Ironsides Resins, Inc., Columbus, Ohio (*T*)
Jones-Dabney Co., Louisville, Ky. (*B, G, BB, CC*)
Kellogg, The M. W. Co., Jersey City, N, J. (*H*)
Knoedler Chem. Co., Lancaster, Pa. (*E*)
●Koppers Co., Inc., Pittsburgh, Pa. (*X, BB*)
L & P Tool Co., Cincinnati, Ohio (*Y*)
Lithgow Chemicals Co., Div., of Reinhold Engineering & Plastics Co., Norwalk, Calif. (*T, BB, II, JJ*)
Loven Chemical of Calif., Newhall, Calif. (*D, E, G, I, K, N, R, T, W, CC, II*)
●Marblette Corp., The, L. I. C., N. Y. (*E, G, T*)
●Marbon Chemical Div., Borg-Warner Corp., Gary, Ind. (*BB*)
Marine Plastics, Inc., Clinton, Mass.
McCloskey Varnish Co., Philadelphia, Pa. (*B*)
Minneapolis Honeywell Regulator, Minneapolis, Minn. (*G*)
Mobay Chemical Co., St. Louis, Mo. (*W*)
Mol-Rez Division-American Petrochemical Corp., Minneapolis, Minn. (*B, N, W, BB, DD*)
Monite Waterproof Glue Co., Minneapolis Minn. (*U, CC, EE*)
●Monsanto Chemical Co., Springfield, Mass. (*Q, T, U, BB, CC, II*)
Monsanto Kasei Chemical Co., Tokyo, Japan (*BB, II*)
Morton Withers Chemical Co., Greensboro, N. C. (*W*)
●Muehlstein, H. & Co., Inc., New York (*A, O, R, T, U, BB, CC, EE, GG, FF*)
●Mycalex Corp., of America, Clifton, N. J. (*J*)
National Adhesives, National Starch Products Inc. (*EE, FF, JJ*)

●Indicates Advertiser.

- National Polymer Products, Inc., Reading (*R*)
- Naugatuck Chemical, Naugatuck, Conn. (*N, W, BB, EE, II*)
- Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*B, N, W, BB, EE, II*)

Neville Chemical Co., Pittsburgh (*F, K, S, DD*)

- Ohio Apex Div. F.M.C., Nitro, W. Va., (*C*)

Osborn, C. J. Company, Linden, N. J. (*B, G, S, DD*)
Pantasote Company, New York (*II*)
Pelron Corporation, Lyons, Ill. (*N, W*)
Pennsylvania Industrial Chemical Corp., Clairton, Penna. (*F, K, L, BB*)
Perkins Glue Co., Lansdale, Pa. (*T, U, Y, CC*)

- Peters Chemical Mfg. Co., Melrose Park, Ill. (*A*)

Pitt-Consol Chemical Co., Newark, N. J. (*T*)

- Pittsburgh Plate Glass Co., Pitts., Pa. (*W*)
- Phillips Chemical Co., Bartlesville, Oklahoma (*X*)
- Plastics Engineering Co., Sheboygan, Wis. (*S, T, U, NN*)

Poly Resins, Sun Valley, Calif. (*E, G, T, U, JJ, NN*)

- Polymer Corp., Reading, Pa. (*H, R, BB*)
- Polypenco, Inc., Reading, Penn. (*H, R, BB*)

Polyrez Company, Inc., Woodbury, N. J. (*D, E, K, S, T, Y, NN*)

- Reed Plastics Corporation, Worcester, Mass. (*A, R, X, BB, II, JJ*)
- Reichhold Chemicals, Inc., White Plains, N. Y. (*B, G, Q, S, T, U, W, Y, CC, DD, EE*)

Ren Plastics Inc., Lansing, Mich. (*G, U*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*II*)
Rexolin, Inc., Santa Monica, Calif. (*E, G, T, V*)
H. H. Robertson Co., Pittsburgh (*G, W*)

- Rohm & Haas Co., Philadelphia, Pa., (*A, B, M, N, Q, S, T, U, W, CC, DD, NN*)
- Rubber Corporation of America, Hicksville, N. Y. (*II*)

Schenectady Varnish Co., Inc., Schenectady, N. Y. (*B, L, S, T, U, V, W, Y, BB, DD, NN*)
Servwell Products Co., Cleveland, Ohio (*FF*)

- Shell Chemical Corporation, New York (*G*)

Sherwin Williams Co., New York (*W, DD*)
Solvic, S. A., Bruxelles, Belgique, (*II, JJ*)
Specialty Resins, Inc., Chicago (*A*)

- Spencer Chemical Co., Kansas City, Mo. (*R, X*)

Stellaron Corporation, New York (*X, BB*)
Sullivan Varnish Co., Chicago (*B, DD*)
Synco Resins Inc., Bethel, Conn. (*S, T, U, EE, NN*)
Synvar Corporation, Wilmington, Del. (*E, I, S, T, U, Y, CC, DD, NN*)
Thalco, Los Angeles (*G, II*)
Tylene Plastics, Inc., Michigan City, Ind. (*G*)

- Union Carbide International Co., New York (*H, S, T, W, X, Z, BB, DD, EE, GG, II, JJ*)
- U. S. Gypsum Co., Chicago (*G*)
- U. S. Industrial Chemicals Co. Div. of National Distillers & Chemical Corp. (*X*)

U. S. Plastic Products Corp., Metuchen, N. J. (*A, B, W*)
U. S. Stoneware Co., Akron, Ohio(*I*)

- Valite Div., Valentine Sugars Inc., New Orleans, La. (*T, U*)

Varcum Chemical Corp., Niagara Falls, N. Y. (*S, T*)

- Westchester Plastics, Inc., Mamaroneck, N. Y. (*X, BB, II, JJ*)
- Witco Chemical Co. (*W*)
- Woloch, George, Co., Inc., New York (*R, X, BB, II, JJ*)

Xylos Rubber Co., Div. of Firestone Tire & Rubber Company, Akron, Ohio (*BB, LL*)

RESIN SOLUTIONS

(See Coatings; Emulsions; Latex; Varnishes)

RODS AND TUBES

(Manufacturers Maintaining Some Stock. For custom extruding see Custom Extruders. For laminated rods and tubes, see Laminators)

For related editorial information see the Plastics Properties Chart.

A. *Acrylate and Methacrylate*
B. *Allyl*
C. *Casein*
D. *Cast Phenolic*
E. *Cellulose Acetate*
F. *Cellulose Acetate Butyrate*
G. *Cellulose Nitrate*
H. *Cellulose Propionate*
I. *Ethyl Cellulose*
J. *Fluorocarbons (Halogenated Ethylenes)*
K. *Glass Bonded Mica*
L. *Nylon (Polyamide)*
M. *Polyester Resins, Cast*
N. *Polyethylene*
O. *Polystyrene*
P. *Polyvinyl Alcohol*
Q. *Polyvinyl Butyral*
R. *Polyvinyl Chloride*
S. *Polyvinyl Chloride Acetate*
T. *Polyvinyl Formal*
U. *Polyvinylidene Chloride*
V. *Silicones*
W. *Styrene Copolymers*

- Ace Plastic Co., Jamaica, New York (*A, E, F, I, N*)

Allegheny Plastics, Inc., Coraopolis, Pa. (*J*)
Alpha Plastics, Inc., Livingston, N. J. (*R*)
Amco Plastic Materials, Inc., Brooklyn, N. Y. (*E, F, I*)

- American Agile Corporation, Maple Hts., Ohio (*J, L, N, R*)

American Hard Rubber Co., New York (*N, O, R, U, W*)
American Pyroxylin Corporation, Arlington, N. J. (*E, G*)
Anchorage Plastics, Warren, R. I. (*M*)

- Anorgana G.M.B.H., Munchen, Germany

Argo Plastic Products, Cleveland (*N, R*)
Aristocrat Plastics, Inc., Newark, N. J. (*A, E, L*)
BX Plastics Ltd., London, England (*C, E, G, N. O, R*)

- Barron, J. E. Plastics, Inc., Cincinnati, Ohio (*A, F, I, L, N, O, R*)
- Bolta Pdts. Div., General Tire & Rubber Co., Lawrence, Mass. (*R, S*)

Borden Co., Chem. Div., New York (*R*)

- Busada Mfg., Corp., Maspeth, N. Y. (*F*)
- Cadillac Plastic & Chemical Co., Detroit (*A, E, F, M, N, O, W*)

Carolin Co., New York, (*J, L*)
Celluplastic Corp., Newark, N.J. (*E,F,N*)
Collins, Caldwell & Dague, Paramount, Calif. (*N, R, W*)

- Colonial Kolonite Co., Chicago (*C, E, L, N, O, W*)
- Commerical Plastics Co., Chicago, (*O, U*)

Commonwealth Pipe & Tubing, Inc., Philadelphia, Pa. (*N, O, R*)

- Continental-Diamond Fibre Corp., Newark, Del. (*J, V*)
- Contour Extrusion Co., Mamaroneck, N. Y. (*N*)

Crane Packing Co., Morton Grove, Ill. (*J*)

- Danielson Manufacturing Co., The, Danielson, Conn. (*L*)
- Davis, Joseph Plastics Co., Arlington, N. J. (*E, F, G, I, N, O, R, S, W*)

Deerfield Plastics Co., Inc., South Deerfield, Mass. (*O*)
Dura Plastics of New York Inc., New York (*A*)

- Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany (*D, E, G, L, N, O, R*)

Electro-Chemical Products Corp., Cleveland (*R*)
Electronic Mechanics, Inc., Clifton, N. J. (*K*)
Emerson & Cuming, Inc., Canton, Mass. (*O*)
Emerson Plastics Corp., Bronx, N. Y. (*A, J, V*)
Fabbrica Prodotti Termoplastici, Varese, Italy (*A, R*)
Fischer, Andrew, Associates, Chicago (*E, F, I, L, N, O, R*)
Franklin Fibre-Lamitex Corp., Wilmington, Del. (*L*)
Garlock Packing Co., Palmyra, N. Y. (*J, L*)

- General Electric Co., Plastics Dept., Decatur, Ill. (*K, R*)

Genesee Laboratory, Inc., Auburn, N. Y. (*N, R, S*)

- Gering Products, Inc., Kenilworth, N. J. (*E, F, I, N, O, R, S, W*)

Glastic Corp., The, Cleveland (*M*)

- Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co., Marietta, Ohio (*R*)
- H & R Industries, Nazareth, Pa. (*A, I, L, N, O, W,*)

Haveg Industries, Inc., Wilmington, Del. (*D, J, M, R, V*)
Homalite Co., The, Wilmington, Del. (*B, M*)

- Hyde, A. L., Co., Glenloch, N. J. (*L*)

Hydrawlik, Roselle, N. J. (*I, L, N, R, S*)

- Imperial Chemical Industries, Ltd., Plastics Div., Hertfordshire, Eng. (*A, N*)

Industrial Sales Engineers, New York (*A, E, F, H, I, L, N, O, P, Q, R, S, W*)
Jessall Plastics, Inc., Kensington, Conn. (*A, E, F, I, L, N. O, P, R, S, U, W*)
Kelley, George A., Fredericktown, Mo. (*A, E, F, H, I, N, O, R, S, W*)
Keystone Packaging Service, Easton, Pa. (*N*)
Knoedler Chemical Co., Lancaster, Pa. (*D*)
Luzerne Rubber Co., Trenton, N. J. (*N, O, R*)
Mannesmann-Easton Plastic Products Co., Inc., Easton, Pa. (*R*)

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

●Marblette Corp., L. I. C., N. Y. (*D*)
Marine Controls Lab., Dixie Plastics Div., New Orleans, La. (*N, O, R, W*)
Marken Plastic Corp., Los Angeles, Calif. (*N, R*)
Mayon Plastics, Hopkins, Minn. (*S*)
Moore Samuel & Co., Mantua, Ohio (*N*)
●Mycalex Corp. of America, Clifton, N. J. (*K*)
●National Vulcanized Fibre Co., Wilmington, Del. (*L, V*)
●Nixon Nitration Works, Nixon, N. J. (*E, F, G*)
Plastic Ind. Prods. Inc., Somerville, Mass. (*N, R, S, W*)
Plastic Pigment Co., Inc., Long Island City, N. Y. (*M*)
Plastic Process Co., Los Angeles, (*A, E, F, I, L, N, O, R, S, U, W*)
Plastron Specialties, Inc., Los Angeles (*A, F, I, L, N, O, S*)
Poly Cell Plastics Co., Smithtown, N. Y. (*E, N, O, R*)
●Polygon Plastic Co., Walkerton, Ind. (*M*)
●The Polymer Corporation, Reading Penn., (*J, L, W*)
●Polypenco, Inc., Reading, Pa. (*J, L, W*)
Reeves Brothers, Inc., New York (*J, L, N, R*)
Reflin Co., San Diego, Calif. (*M*)
Reliance Plastic & Chemical Corp., Paterson, N. J. (*N, R, S*)
Resinite Department, The Borden Co., Santa Barbara, Calif. (*R*)
Resistoflex Corp., Roseland, N. J. (*J, P*)
Rosenberg Bros. & Co., Smithtown, N. Y. (*E*)
●Rotuba Extruders Inc., Brooklyn, N. Y. (*A, E, F, I, O*)
Rowland Products, Inc., Kensington, Conn. (*F, R*)
Joseph T. Ryerson & Son, Inc., Chicago, Ill. (*R*)
●Schwab Plastics Corp., Detroit, Mich. (*E, F, I, L, N, O, R, S, W*)
●Sheffield Plastics, Inc., Sheffield, Mass. (*R*)
Shoe Form Co., Inc., Auburn, New York (*F*)
●Southern Plastics Co., Columbia, S. C. (*A, E, F, H, I, J, L, N, O, R, S, W*)
●Sunlite Plastics, Inc., Milwaukee, Wis. (*E, F, I, L, N, O, R, S*)
●Superior Plastics Inc., Chicago (*E, F, I, N, O, P, Q, R, S*)
Tri-Point Plastics Inc., Albertson, N. Y. (*J*)
●United States Gasket Co., Camden, N. J. (*J, L*)
U. S. Plastic Products Corp., Metuchen, N. J. (*A*)
U.S. Stoneware Co., Akron, Ohio (*N, R*)
●Van Dorn Iron Works Co., Cleveland, Ohio (*U*)
Vulcanized Rubber and Plastics Co., Morrisville, Penna. (*V*)
●Weljohn Plastics Inc., Brooklyn, N. Y. (*R, S*)
Westinghouse Electric Corp., Micarta Div., Hampton, S. C. (*L, N, V*)
Western Plastics Corp., Hastings, Nebraska (*E, F, L, N, R, W*)
Western Plastics Corp., Tacoma, Wash. (*N, R, W*)
Westlake Plastics Company, Lenni Mills, Pa. (*A, E, I, J, N, O, W*)
Worble Ltd., Nr. Berne, Switzerland (*E, G, R, S*)
Yates Company, Erie, Pa. (*E, F, N, R, X*)

●Indicates Advertiser.

RUBBERLIKE PLASTICS
(Elastomers)

Adhesive Products, Corporation, New York
Alkydol Laboratories, Inc., Cicero, Ill.
American Hard Rubber Co., New York
Borden Co., Chemical Div., New York
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass.
●Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Elastomer Chemical Corp., Newark, N. J.
Garlock Packing Co., Palmyra, N. Y.
●Hardman, H. V., Co., Belleville, N. J.
Houghton Laboratories, Inc., Olean, N. Y.
Kelley, George A., Fredericktown, Mo.
Kellogg, The M. W., Co., Jersey City, N. J.
Lithgow Chemicals Co., Div. of Reinhold Engineering & Plastics Co., Norwalk, Calif.
Luzerne Rubber Co., Trenton, N. J.
Marine Control Labs., Dixie Plastics Div., New Orleans, La.
●Naugatuck Chemical, Naugatuck Conn.
●Schwartz Chemical Co., Inc., New York

RUBBER, SYNTHETIC

For related editorial information see the Plastics Properties Chart; also p. 86

A. *Butadiene-stryene*
B. *Butadiene-acrylonitrile*
C. *Chloroprene*
D. *Isocyanate*
E. *Polyisobutylene*
F. *Polysulfide*
G. *Silicone*
H. *Chlorosulfonated Polyethylene*

American Hard Rubber Co., New York (*B*)
Applied Plastics, Co., Inc., El Segundo, Calif. (*D*)
●Badische Anilin & Soda Fabrik A.G., Ludroigshafen Rhein, Germany (*F*)
Borden Co., Chemical Div., New York (*A, B*)
●Chemische Werke Huls A.G., Marl, W. Germany (*A*)
●Dewey & Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass. (*A*)
Dow Corning Corp., Midland, Mich. (*G*)
●du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del. (*C, H*)
Emerson & Cuming, Inc., Canton, Mass. (*F*)
●Enjay Co., Inc., New York (*E*)
●Firestone Plastics Co., Pottstown, Pa. (*A*)
Garlock Packing Co., Palmyra, N. Y. (*A, B, G*)
●General Electric Co., Plastics Dept., Decatur, Ill. (*H*)
●Goodrich, B. F. Chemical Co., Cleveland, Ohio (*A, B*)
●Goodyear Tire & Rubber Co., The, Chemical Div., Akron, Ohio (*A, B*)
Greer Industries, Inc., Jamaica, N. Y. (*E*)
Heresite & Chemical Co., Manitowoc, Wis. (*B*)
●Imperial Chemical Industries Ltd., Plastics Div., Herefordshire, Eng. (*A, B*)
Kelley, George A., Fredericktown, Mo. (*A, B*)
●Koppers Co., Inc., Pittsburgh, Pa. (*A*)
Luzerne Rubber Co., Trenton, N. J.
Marine Controls Labs., Dixie Plastics Div., New Orleans, La. (*A, B*)
●Naugatuck Chemical, Naugatuck, Conn. (*A, B, D*)
●Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn. (*A, B, D*)
●Southern Plastics Co., Columbia, S. C. (*A, B*)
Westlake Plastics Company, Lenni Mills, Pa. (*A, B*)
●Woloch, George, Co., Inc., New York (*A, B*)
Xylos Rubber Co., Div. of Firestone Tire & Rubber Company, Akron, Ohio (*B*)

SHEETS, RIGID

(For laminated sheets, see Laminates and Laminators. For low pressure sheets, see Reinforced Plastics)

For related editorial information see p. 434

A. *Acrylate and Methacrylate*
B. *Allyl*
C. *Casein*
D. *Cast Phenolic*
E. *Cellulose Acetate*
F. *Cellulose Acetate Butyrate*
G. *Cellulose Nitrate*
H. *Cellulose Propionate*
I. *Cellulose Triacetate*
J. *Ethyl Cellulose*
K. *Fluorocarbons (Halogenated Ethylenes)*
L. *Glass Bonded Mica*
M. *Nylon (Polyamide)*
N. *Polyester Resins, Cast*
O. *Polyethylene*
P. *Polystyrene*
Q. *Polyvinyl Alcohol*
R. *Polyvinyl Butyral*
S. *Polyvinyl Chloride*
T. *Polyvinyl Chloride Acetate*
U. *Polyvinyl Formal*
V. *Polyvinylidene Chloride*
W. *Silicones*
X. *Styrene Copolymers*

●Ace Plastic Co., Jamaica, New York (*A, E, F, J, O*)
●Acme Resin Corporation, Forest Pk., Ill. (*K*)
Allegheny Plastics, Inc., Coraopolis, Pa. (*K*)
Amco Plastic Materials, Inc., Brooklyn, N. Y. (*E, F, S*)
●American Agile Corporation, Maple Hts., Ohio (*K, M, O, S*)
American Hard Rubber Co., New York (*S, V, X*)
American Pyroxylin Corporation, Arlington, N. J. (*E, G*)
●Anorgana G.M.B.H., Munchen, Germany (*S*)
Argo Plastic Products, Cleveland (*O, P, S, X*)
Aristocrat Plastics, Inc., Newark, N. J. (*A, E, J, M, O, P*)
Armen, Inc., Long Island City, N. Y. (*K*)
●Auburn Button Works, Inc., Auburn, N. Y. (*A, I, S, X*)
BX Plastics Ltd., London, England (*A, C, E, G, I, J, P, S, X*)

- **Bakelite Co., A Div. of Union Carbide Corp.,** New York (*S, T*)
- **Barron, J. E. Plastics, Inc.,** Cincinnati, Ohio (*A, E, F, I, K, M, N, O, P, S, T*)
- **Blum Paul Co.,** Buffalo, N. Y. (*A,E,G*)
- **Bolta Pdts. Div., General Tire & Rubber Co.,** Lawrence, Mass. (*S,T,X*)
- **Cadillac Plastic & Chemical Co.,** Detroit (*A, E, F, N, O, P, X*)
- **Canadian Resins & Chemicals, Ltd.,** Montreal, Quebec, Canada (*S, T*)
- **Cast Optics Corp.,** Hackensack, N. J. (*A, N*)
- **Celanese Corp. of America,** Newark, N. J. (*E*)
- **Chemtron Fiber Glass Co.,** El Monte, Calif. (*N*)
- **Colonial Kolonite Co.,** Chicago (*F, M*)
- **Commercial Plastics Co.,** Chicago (*V*)
- **Continental-Diamond Fibre Corp.,** Newark, Del. (*K, M, W*)
- **Crane Packing Co.,** Morton Grove, Ill. (*K*)
- **Crowl, Charles, Co.,** El Monte, Calif. (*P, S, X*)
- **Curry Arts Molding & Laminating Co.,** Scranton, Pa. (*A, E, S*)
- **Danielson Manufacturing Co., The,** Danielson, Conn. (*M*)
- **Davis, Joseph Plastics Co.,** Arlington, N. J. (*A, E, F, G, J, O, P, S, T, X*)
- **Dow Chemical Co.,** Midland, Mich. (*J, V*)
- **du Pont, E. I. de Nemours & Co., Inc.,** Wilmington, Del. (*E, F, G*)
- **Dura Plastics of New York, Inc.,** New York (*A*)
- **Dynamit-Actien-Gesellschaft,** Troisdorf, W. Germany (*D*)
- **Eastman Kodak Co., Cellulose Prodcuts Div.,** Rochester, N. Y. (*E, F, I*)
- **Electro-Chemical Products Corp.,** Cleveland (*S*)
- **Electronic Mechanics, Inc.,** Clifton, N. J. (*K, L*)
- **Emerson & Cuming, Inc.,** Canton, Mass. (*P*)
- **Emerson Plastics Corp.,** Bronx, N. Y. (*A, E, F, K, W*)
- **Everlite Corp.,** Seattle, Wash. (*N*)
- **Fabbrica Prodotti Termoplastici,** Varese, Italy (*A*)
- **Ferplex Chemicals, Inc.,** New York (*E, G, S*)
- **Fiber Glass Plastic, Inc.,** Hialeah, Fla. (*P*)
- **Firestone Plastics Co.,** Pottstown, Pa. (*S*)
- **Fischer, Andrews Associates,** Chicago (*E, F*)
- **Form-A-Lite, Inc.,** Northbridge, Mass. (*S, T*)
- **Franklin Fibre-Lamitex Corp.,** Wilmington, Del. (*M, W*)
- **Garlock Packing Co.,** Palmyra, N. Y. (*K, W*)
- **General Electric Co., Plastics Dept.,** Decatur, Ill. (*L*)
- **General Tire & Rubber Co., The,** Akron, Ohio (*S*)
- **Gering Products, Inc.,** Kenilworth, N. J. (*A, O, P. X*)
- **Gilman Brothers Co., The,** Gilman, Conn. (*O, P, X*)
- **Glastic Corp., The,** Cleveland (*N*)
- **Goodrich, B. F., Industrial Products Co., Div. of B. F. Goodrich Co.,** Marietta, Ohio (*S*)
- **H & R Industries,** Nazareth, Pa. (*M, O*)
- **Haveg Industries, Inc.,** Wilmington, Del. (*D, K, N, S*)
- **Heil Process Equipment Corp., Rigidon Plastic Div.,** Cleveland (*N*)
- **Homalite Co.,** Wilmington, Del. (*B, N*)
- **Hyde, A. L., Co.,** Grenloch, N. J. (*M*)
- **Imperial Chemical Industries Ltd., Plastics Div.,** Hertfordshire, Eng. (*A, M, O, S*)
- **Industrial Sales Engineers,** New York (*A, F, O, X*)
- **Keystone Packaging Service,** Easton, Pa. (*O*)
- **Larc Products, Inc.,** Amsterdam, N. Y. (*A*)
- **Lurie Plastics Inc.,** Colonial Hghts., Va. (*O, P*)
- **Lus-Trus Corp.,** Ypsilanti, Mich. (*E, F, O, P, X*)
- **Malco Plastics, Inc.,** Baltimore, Md. (*F, T*)
- **Marblette Corp., The,** L. I. C., N. Y. (*D*)
- **Midwest Plastic Products Co.,** Chicago Heights, Ill. (*A, E, F, O, P, X*)
- **Monsanto Chemical Co.,** Springfield, Mass. (*G*)
- **Muehlstein, H., & Co., Inc.,** New York (*A, P, R, S, T*)
- **Mycalex Corp. of America,** Clifton, N. J. (*L*)
- **National Vulcanized Fibre Co.,** Wilmington, Del. (*W*)
- **Nixon Nitration Works,** Nixon, N. J. (*E, F, G, O, S, T, X*)
- **O'Sullivan Rubber Corp.,** Winchester, Virginia (*X*)
- **Plastex Process Co.,** Maywood, N. J. (*M*)
- **Plastic Ind. Prods Inc.,** Somerville, Mass. (*X*)
- **Plastic Pigment Co., Inc.,** Long Island City, N. Y. (*N*)
- **Plastic Process Co.,** Los Angeles (*A, E, F, J, O, P, X*)
- **Plastofilm, Inc.,** Wheaton, Ill. (*E, F*)
- **Plastron Specialties, Inc.,** Los Angeles (*F, O, P*)
- **Poly Cell Plastics Co.,** Smithtown, N. Y. (*E, O, P*)
- **Polycast Corp.,** Stamford, Conn. (*A, B*)
- **Polymer Corporation,** Reading, Penn. (*K, M, X*)
- **Polypenco, Inc.,** Reading, Pa. (*K, M, X*)
- **Polyplastex United, Inc.,** Union, N. J. (*S*)
- **Raritan Industries,** Paterson, N. J. (*O, P, X*)
- **Resinite Department, The Borden Co.,** Santa Barbara, Calif. (*S*)
- **Resistoflex Corp.,** Roseland, N. J. (*K, O*)
- **Respro Division The General Tire & Rubber Co.,** Cranston, R. I. (*T*)
- **Rohm & Haas Co.,** Philadelphia, Pa. (*A*)
- **Rotuba Extruders Inc.,** Brooklyn, N. Y. (*A, E, O, S, X*)
- **Rowland Products Inc.,** Kensington, Conn. (*F, G*)
- **Rubber Corporation of America,** Hicksville, N. Y. (*S*)
- **Ryerson, Joseph T. & Son, Inc.,** Chicago, Ill. (*S*)
- **Sandee Mfg. Co.,** Chicago (*A, F, J, O, P, X*)
- **Schori Process Div. of Ferro-Co, Corp.,** New York (*N*)
- **Scranton Plastic Laminating Corp.,** Scranton, Pa. (*A, E, F, O, P, S, T*)
- **Seiberling Rubber Co.,** Newcomerstown, Ohio (*O, P, S, T, X*)
- **Sheffield Plastics, Inc.,** Sheffield, Mass. (*A, O, P, X*)
- **Shoe Form Co., Inc.,** Auburn, New York (*F*)
- **Shore Line Industries,** Clinton, Conn. (*O*)
- **Southern Plastics Co.,** Columbia, S. C. (*A, E, F, H, J, K, M, O, P, S, T, X*)
- **Superior Plastics Inc.,** Chicago (*E, F, O, P*)
- **Synthane Corp.,** Oake, Penna. (*W*)
- **Transilwrap Co.,** Chicago (*A, E, F, I, O, P, S, T*)
- **Union Carbide International Co.,** New York (*T*)
- **United States Gasket Co.,** Camden, N. J. (*K*)
- **U. S. Plastic Products Corp.,** Metuchen, N. J. (*A, N*)
- **Van Dorn Iron Works Co.,** Cleveland, Ohio (*S*)
- **Wasco Products Inc.,** Cambridge, Mass. (*A*)
- **Westinghouse Electric Corp.,** Micarta Div., Hampton, S. C. (*N, O, W*)
- **Westlake Plastics Company,** Lenni Mills, Pa. (*A, K, O, P, X*)
- **Worbla Ltd.,** nr. Berne, Switzerland (*E, G, S, T*)

● Indicates Advertiser.

SOLVENTS

For related editorial information see p. 385

A. *Alcohols*
B. *Amines*
C. *Esters*
F. *Ethers*
E. *Furans*
F. *Glycols*
G. *Halogenated Compounds*
H. *Hydrocarbons*
I. *Ketones*
J. *Nitriles*
K. *Nitrohydrocarbons*
L. *Sulfur Compounds*

- **American Cyanamid Co., Adhesive, Resin and Chem. Div.,** New York (*C*)
- **Amoco Chemicals Corp.,** Chicago (*H*)
- **Anorgana, G. M. B. H.,** Munchen, Germany (*B, F*)
- **Antara Chemicals, A Sales Div. of General Aniline & Film Corp.,** New York (*F*)
- **Badische Anilin & Soda Fabrik A.G.,** Ludroigshafen Rhein, Germany (*A, B, C, D, F, G, H, I, J, K, L*)
- **Barrett Div., Allied Chemical & Dye Corp.,** New York (*F, H*)
- **Carbide & Chemicals Co.,** New York (*A, B, C, D, F, G, H, I, J, L*)
- **Celanese Corp. of America, Chemical Div.,** New York (*A, C, F, I*)
- **Chemical Development Corp.,** Danvers, Mass. (*A, B, G, H, I*)
- **Diamond Alkali Co., Chlorowax Div.,** Cleveland (*G*)
- **Dow Chemical Co.,** Midland, Mich. (*B, F, G*)
- **du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.** (*A, B, C, F, G, H*)
- **Eastman Chemical Products, Inc.,** Kingsport, Tenn. (*A, C, I*)
- **Enjay Co., Inc.,** New York (*A, C, D, I*)
- **Farbwerke Hoechst A.G. vormals Meister Lucius & Brüning,** Ffm Hoechst, Germany (*A,C,D,F,G,H,I*)
- **Fine Organics, Inc.,** New York (*G*)
- **Greeff, R. W., & Co., Inc.,** New York (*A, C, I*)
- **Heyden Newport Chemical Corp.,** New York (*G*)
- **Hommel, O. Co., The,** Pittsburgh (*A, C, I*)
- **Kay Fries Chemicals, Inc., American British Chemical Supplies, Inc.,** New York (*A, C, D, I, J*)

Kelker Chemical Corp., Newark, N. J. (*G*)
• Koppers Co., Inc., Pittsburgh, Pa. (*H*)
Montrose Chemical Co., Newark, N. J. (*G*)
Morton Withers Chemical Co., Greensboro, N. C. (*C*)
Neville Chemical Co., Pittsburgh (*H*)
Pennsylvania Industrial Chemical Corp., Clairton, Penna. (*H*)
Pennsylvania Salt Mfg. Co., Phila., Penna. (*A, B, C, D, G, H, L*)
The Quaker Oats Co., Chicago (*E*)
• Rohm & Haas Co., Philadelphia, Pa. (*B*)
• Shell Chemical Corporation, New York (*A, I*)
• U. S. Industrial Chemicals Co. Div. of National Distillers & Chemical Corp., New York (*A, C, D, H, I*)
Union Oil Co. of California, Los Angeles, Calif. (*H*)
Wallace & Tiernan Inc., Belleville N. J. (*A, I*)

STABILIZERS

For related editorial information see p. 377

• Advance Solvents & Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, N. J.
• American Cyanamid Co., Adhesive, Resins and Chemicals Div., New York
• Antara Chemicals, A Sales Div. of General Aniline & Film Corp., New York
• Argus Chemical Corp., Brooklyn, New York
Baker Castor Oil Co., Bayonne, N. J.
• Carbide & Chemicals Co., New York
• Deecy Products Co., Cambridge, Mass.
Eagle-Picher Co., Cincinnati, Ohio
Ferro Chemical Corp., Bedford, Ohio
• Harshaw Chemical Co., Cleveland, Ohio
• Heyden Newport Chemical Corp., New York
Merix Chemical Co., Chicago
• Metal & Thermit Corp., Rahway, N. J.
• Naugatuck Chemical, Naugatuck, Conn.
• Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn.
Pennsylvania Salt Mfg. Co., Phila., Penna.
• Synthetic Products Co., Cleveland
• Witco Chemical Co., New York

SUPPORTED FILM AND SHEETING

(See Fabrics, Coated)

VARNISHES, INSULATING, LAMINATING

(See also Coatings)

For related editorial information see p. 175

John L. Armitage & Co., Newark, N. J.
• Bakelite Co., A Div. of Union Carbide Corp., New York
• Barrett Div., Allied Chemical & Dye Corp., New York
Doxam Products, Inc., Middlesex, N. J.
Dow Corning Corp., Midland, Mich.
• du Pont, E. I., de Nemours & Co., Inc., Wilmington, Del.
Haveg Industries, Inc., Wilmington, Del.
Heresite & Chemical Co., Manitowoc, Wis.
Ironsides Resins, Inc., Columbus, Ohio
Magic Chemical Co., Brockton, Mass.
• Marblette Corp., The, L. I. C., N. Y.
McCloskey Varnish Co., Philadelphia, Pa.
• Plastics Engineering Co., Sheboygan, Wis.
• Schwartz Chemical Co., Inc., New York
Sherwin Williams Co., New York
• Sullivan Varnish Co., Chicago
Varcum Chemical Corp., Niagara Falls, N. Y. (*K*)
Westinghouse Electric Corp., Micarta Div., Hampton, S. C.
Wilross Products Co., Hawthorne, N. J.

VULCANIZING AGENTS

• American Cyanamid Co., Adhesives, Resins and Chemical Div., New York
• Badische Anilin & Soda Fabrik A.G., Rhein, Germany
Borden Co., Chemical Div., New York
• du Pont, E. I., de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., Wilmington, Del.
• Naugatuck Chemical, Naugatuck, Conn.
• Naugatuck Chemical, U.S. Rubber Co., Naugatuck, Conn.
Specialty Resins, Inc., Chicago
Xylos Rubber Co., Div. of Firestone Tire & Rubber Company

WETTING AGENTS

• Advance Solvents & Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, N. J.
Air Reduction Chemical Co., New York
• American Cyanamid Co., Organic & Pigments Div., New York
• American Cyanamid Co., Adhesives, Resins and Chemicals Div., New York
• American Molding Powder & Chemical Corp., Brooklyn, N. Y.
• Antara Chemicals, A sales Div. of General Aniline & Film Corp., New York
• Badische Anilin & Soda Fabrik A.G., Rhein, Germany
• Carbide & Chemicals Co., New York
Carlisle Chemical Works, Reading, Ohio
• du Pont, E. I. de Nemours & Co., Inc., Wilmington, Del.
• Ferro Corp., Plastic Color Div., Cleveland, Ohio
Glyco Products Co., Inc., New York
Houghton, E. F. & Co., Philadelphia, Pa.
Kessler Chemical Co., Inc., Philadelphia, Pa.
• Krieger Color & Chemical Co., Inc., Los Angeles, Calif.
Merix Chemical Co., Chicago, Ill.
Morton Withers Chemical Co., Greensboro, N. C.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.
• Plastics Engineering Co., Sheboygan, Wis.
• Plastic Molders Supply Co., Inc., Fanwood, N. J.
• Reichhold Chemicals, Inc., White Plains, N. Y.
• Rohm & Haas Co., Philadelphia, Pa.
Specialty Products Co., Jersey, N. J.
Superior Materials Inc., New York

MACHINERY

For related editorial information see pp. 650, 890

BLOWERS, PORTABLE ELECTRIC

(Dust, Dry Air, Etc.)

Standard Electric Mfg., Co., Inc., West Berlin, N.J.

COMPRESSORS, AIR

Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
American Air Compressor Co., North Bergen, N.J.
Bellows Co., Akron, Ohio
Binks Manufacturing Co., Chicago
Carrier Corp., Syracuse, N.Y.
• DeVilbiss Company, Toledo, Ohio
• Lawton, C. A., Co., De Pere, Wisc.
Nash Engineering Company, Norwalk, Conn.
• Newbury Industries, Inc., Newbury, Ohio
Pennsylvania Pump & Compressor Co., Easton, Pa.
Quincy Compressor Co., Quincy, Ill.
• Shaw, Francis & Co., Ltd., Manchester, Eng.

CUTTERS, GUILLOTINE

Albert, L., Div. of Bellanca Corp., Trenton, N. J.
Barker-Davis Machine, Leominster, Mass.
• Custom Machine & Design, Inc., Akron, Ohio
• Doven Mach. & Eng., Inc., Chicago
• Gane Bros. & Lane, Inc., Chicago
Harmann Bertorff Maschinenbau-Anstalt G.M.B.H., Hannover, Germany
Hydro-Chemie Limited, Zurich, Switzerland
• Karlton Machinery Corp., Chicago
• Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N.Y.
• Niagara Machine & Tool Works, Buffalo, N.Y.
• Progressive Machine Co., Inc., Paterson, N. J.
• Robbins Plastic Machinery Corp., Elkhart, Ind.
Sherman Rubber Machinery Co., Worcester, Mass.
Spadone Machine Company, Inc., S. Norwalk, Conn.
• Stokes, F. J., Corp., Phila., Pa.
Utility Mfg. Co., Cudahy, Wisc.

• Indicates Advertiser.

Vern Emery Co., Sun Valley, Calif.
● Waldron, John Corp., New Brunswick, N. J.
● Western Supplies Co., St. Louis, Mo.
Wysong & Miles, Co., Greensboro, N. C.

CUTTERS, MULTI-LAYER FILM

Eastman Machine Co., Buffalo, N. Y.

ABRASIVE FORMING MACHINES

● Elmes Engineering Division, Cincinnati, Ohio
● Erie Foundry Company, Erie, Pa.
● Lake Erie Engineering Corp., Kenmore, N. Y.

BEVELING MACHINES

● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
● Mico Instrument Co., Cambridge, Mass.
Sommer & Maca Glass Co., Chicago
● Standard Tool Co., Leominster, Mass.

BLENDING MACHINES

● Abbe, Paul O., Inc., Little Falls, N. J.
Applied Engineering Associates, Brooklyn, N. Y.
● Bailey, R. N., Co., Inc., New York
Baker Perkins, Inc., Saginaw, Mich.
Colton, Arthur, Company, Detroit, Mich.
● Entoleter Division, Safety Industries, Inc., New Haven, Conn.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
Morse Mfg., Co., Inc., Syracuse, N. Y.
Patterson Foundry & Machine Company, E. Liverpool, Ohio
Read Standard Division of Capitol Products Corp., York, Pa.
● Ross, Charles & Son, Company, Brooklyn, N. Y.
Sprout, Waldron & Co., Inc., Muncy, Pa.
Sturtevant Mill Company, Dorchester, Boston, Mass.
Young Machinery Co., Muncy, Pa.

BLOW MOLDING MACHINES

● Battenfeld, Gebr., Meinerzhagen, West Germany
Machine Factory & Foundry Ltd. Netstal/GL., Switzerland
● Newark Die Company, Newark, N. J.
● Windsor, R. H., Limited, Chessington, England

BUFFING MACHINES

● Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Maplewood Companies, Livingston, N. J.
● Nash, J. M., Co., Inc., Milwaukee, Wisc.
Sommer & Maca Glass Machinery Co., Chicago
Wyzenbeek & Staff, Inc., Chicago, Ill.

CALENDERING MACHINES

● Adamson United Company, Akron, Ohio
Albert L. & Son., Trenton, N. J.
● Bolling, Stewart & Co., Cleveland, Ohio
Comerio Ercole S.P.A., Busto Arsizio, Italy
● Custom Machine & Design, Inc., Akron, Ohio
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
Heinrich, H. H., Co., New York
Hermann Bertorff Maschinenbau-Anstalt G.M.B.H., Hannover, Germany
Into-Roto Machine Co., Richmond, Va.
● Liberty Machine Co., Inc., Paterson, N. J.
● Litzler, C. A., Co., Inc., Cleveland, Ohio
Rollis Incorporated, Brooklyn, N. Y.
● Ross, Charles & Son, Company, Brooklyn, N. Y.
● Shaw, Francis & Co., Ltd., Manchester, England
Sherman Rubber Machinery Co., Worcester, Mass.
● Thropp, W. M. R., & Sons, Div. of J. M. Lehmann Co., Inc., Lyndhurst, N. J.

COATING MACHINES

Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
● Apex Machine Co., College Point, N. Y.
Applied Engineering Associates, Brooklyn, N. Y.
● Black-Clawson Co., Inc., Fulton, N. Y.
Blue, E. B., S. Norwalk, Conn.
Comerio Ercole S.P.A., Busto Arsizio, Italy
● DeVilbiss Company, Toledo, Ohio
Dornbusch & Co., Krefeld, Germany
● Doven Mach. & Eng., Inc., Chicago
● Dusenbery, John, Co., Inc., Verona, N. J.
● Egan, Frank W., & Co., Somerville, N. J.
Fabbrica Prodotti Termoplastici, Carlo Pasquetti, Varese, Italy
● Faeco Machine Co., Paterson, N. J.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
General Engineering Co., Cury Road, Radcliffe
● Hartig Engine & Machine Co., Hillside, N. J.
● Hofmann & Schwabe, K. G., Krefeld, West Germany
Hunt, Rodney, Co., Orange, Mass.
● Industrial Ovens, Inc., Cleveland, Ohio
Into-Roto Machine Co., Richmond, Va.
Lembo Machine Works, Inc., Paterson, N. J.
● Liberty Machine Co., Paterson, N. J.
● Litzler, C. A., Co., Inc., Cleveland, Ohio
● N. R. C. Equipment Corp., Newton, Mass.
● Polymer Corp., The, Reading, Pa.
● Prodex Corp., Fords, N. J.
● Reifenhäuser, A., Troisdorf, Germany
Rollis Incorporated, Brooklyn, N. Y.
Seal-Peel, Inc., Royal Oak, Mich.
Sherman Rubber Machinery Co., Worcester, Mass.
● Waldron, John Corp., New Brunswick, N. J.
Western Coating Co., Royal Oak, Mich.

COMPOUNDING MACHINES

Baker Perkins, Inc., Saginaw, Mich.
Beardsley & Piper, Div. Pettibone Milliken, Corp., Chicago
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
● Hale & Kullgren, Inc., Akron, Ohio
● Hartig Engine & Machine Co., Hillside, N. J.
Heinrich, H. H., Co., New York
● Prodex Corp., Fords, N. J.
● Progressive Machine Co., Paterson, N. J.
● Ross, Charles & Son, Company, Brooklyn, N. Y.
● Shaw, Francis & Co., Ltd., Manchester, England
Sherman Rubber Machinery Co., Worcester, Mass.
● Welding Engineers, Inc., Norristown, Pa.

COOLING MACHINES

● Akron Presform Mold Co., Cuyahoga Falls, Ohio
● Black-Clawson Co., Inc., Fulton, N. Y.
Blue, E. B., Co., S. Norwalk, Conn.
Carrier Corp., Syracuse, N. Y.
● Custom Engineering Co., Erie, Pa.
● Detroit Stamping Co., Detroit, Mich.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
Lembo Machine Works, Inc., Paterson, N. J.
● Liberty Machine Co., Inc., Paterson, N. J.
● Litzler, C. A., Co., Inc., Cleveland, Ohio
● Mayer Refrigerating Engrs., Inc., Lincoln Park, N. J.
● Mercury Industries, Inc., Killsdale, N. J.
Vic Mfg. Co., Minneapolis, Minn.

CUT-OFF MACHINES

(and Stacking)

● Akron Presform Mold Co., Cuyahoga Falls, Ohio
Al-Be Industries, Bell Garden, Calif.
Barker-Davis Machine, Leominster, Mass.
Beck, Charles, King of Prussia, Pa.
● Cumberland Engineering Co., Inc., Providence, Rhode Island
● Doven Mach. & Eng., Inc., Chicago
Eastman Machine Company, Buffalo, New York
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
● Faeco Machine Co., Inc., Paterson, N. J.
● Falls Engineering & Machine Co., Cuyahoga Falls, Ohio
● Foster & Allen, Inc., Garwood, N. J.
Heinrich, H. H., Co., New York
● Hobbs Manufacturing Co., Worcester, Mass.
Hydro-Chemie Ltd., Zurich, Switzerland
Ketchpel Engineering Co., West Englewood, N. J.
● Liberty Machine Co., Paterson, N. J.
● Litzler, C. A., Co., Inc., Cleveland, Ohio
● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
O'Neil-Irwin Mfg. Co., Lake City, Minn.
● Progressive Machine Co., Inc., Paterson, N. J.
Rainville Co., Inc., Garden City, N. Y.
● Robbins Plastic Machinery Corp., Elkhart, Ind.
● Stokes, F. J., Corp., Phila., Pa.
Stone, S. G., Tube Machine Corp., Chicago
Sommer & Maca Glass Machinery Co., Chicago
● Thropp, Wm. R., & Sons, Div. of J. M. Lehmann Co., Inc., Lyndhurst, N. J.
Utility Mfg. Co., Cudahy, Wisc.
Vern Emery Co., Sun Valley, Calif.
● Western Supplies Co., St. Louis, Mo.

CUTTING & SLITTING MACHINES, FIBROUS GLASS

● Dusenbery, John Company, Inc., Verona, N. J.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

Eastman Machine Company, Buffalo, N. Y.
•Falls Engineering & Machine Co., Cuyahoga Falls, Ohio
•Liberty Machine Co., Inc., Paterson, N. J.
Maimin, H., Co., Inc., New York
Ruf Machine Co., Inc., New York
Spadone Machine Company, Inc., S. Norwalk, Conn.
Stone, S. G., Machine Corp., Chicago
Swan Machine Company, New York
•Taylor Stiles & Co., Riegelsville, N.J.
•Western Supplies Co., St. Louis, Mo.

DEFLASHING MACHINES

Buttondex Corp., New York
•Falls Engineering & Machine Co., Cuyahoga Falls, Ohio
Ketchpel Engineering Co., West Englewood, N. J.
Loed Chemical Corp., York, Pa.
•Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Maplewood Companies, Livingston, N. J.
•Nash, J. M., Co., Inc., Milwaukee, Wisc.
Pangborn Corp., Hagerstown, Md.
•Western Supplies Co., St. Louis, Mo.

DENSIFYING MACHINES

Baker Perkins, Inc., Saginaw, Mich.
Beardsley & Piper, Div. Pettibone Mulliken Corp., Chicago
•Hale & Kullgren, Inc., Akron, Ohio
Sprout, Waldron & Co., Inc., Muncy, Pa.

DICING, CHOPPING AND CUTTING MACHINES

Abbe Engineering Co., New York, N. Y.
Al-Be Industries, Bell Garden, Calif.
Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
Alsteele Engineering Works, Inc., Framingham, Mass.
Ball & Jewell, Inc., Brooklyn, N. Y.
•Cumberland Engineering Co., Inc., Providence, R. I.
•Custom Machine & Design, Inc., Akron, Ohio
Eastman Machine Company, Buffalo, N. Y.
•Egan, Frank W., & Co., Somerville, N. J.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
•Hale & Kullgren, Inc., Akron, Ohio
•Hartig Engine & Machine Co., Hillside, N. J.
•Killion Tool & Mfg. Co., Verona, N. J.
Miller, Franklin P., & Son, Inc., East Orange, N. J.
Mitts & Merrill, Saginaw, Mich.
•Modern Plastic Machinery Corp., Lodi, N. J.
•National Rubber Machinery Co., Akron, Ohio
Rainville Co., Inc., Garden City, N. Y.
Ruf Machine Co., Inc., New York
Sprout, Waldron & Co., Inc., Muncy, Pa.
•Stokes, F. J., Corp., Philadelphia, Pa.
•Taylor Stiles & Company, Riegelsville, N. J.
•Van Dorn Iron Works, Co., Cleveland, Ohio

DIPPING MACHINES

•Akron Presform Mold Co., Cuyahaga Falls, Ohio
•Apex Machine Co., College Point, N. Y.

•Indicates Advertiser.

Applied Engineering Associates, Brooklyn, N. Y.
Blue, B. E., Co., S. Norwalk, Conn.
•Cumberland Engineering Co., Inc., Providence, Rhode Island
Dec-Art Process Co., Inc., New York
•Egan, Frank W., & Co., Somerville, N. J.
•Industrial Ovens Inc., Cleveland, Ohio
•Mercury Industries, Inc., Hillsdale, N. J.
•Litzler, C. A., Co., Inc., Cleveland, Ohio

EXTRUDING MACHINES

Baker Perkins, Inc., Saginaw, Mich.
Comerio Ercole S.P.A., Busto Ansizio, Italy
•Davis-Standard, Div. of Franklin Research, Mystic, Conn.
•Egan, Frank W., & Co., Somerville, N. J.
•Erie Foundry Company, Erie, Pa.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Verese, Italy
•Farrel-Birmingham Company, Inc., Ansonia, Conn.
General Engineering Co., Radcliffe Ltd., Cury Road, Radcliffe
Guild Electronics, Inc., New York
•Hale & Kullgren, Akron, Ohio
•Hartig Engine & Machine Co., Hillside, N. J.
Heinrich, H. H., Co., New York
Hermann Bertorff Maschinenbau-Anstalt G.M.B.H., Hannover, Germany
•Karlton Machinery Corp., Chicago, Ill.
•Killion Tool & Mfg. Co., Verona, N. J.
Lommis Engineering & Mfg. Company, Newark, N. J.
Marine Plastics, Inc., Clinton, Mass.
•Modern Plastic Machinery Corp., Lodi, N. J.
•National Rubber Machinery Co., Akron, Ohio
•Negri, Bossi & Co., Milano, Italy
•Peco Machinery Sales (Westminster) Ltd., London, England
•Prodex Corp., Fords, N. J.
•Reed-Prentice Corp., Worcester, Mass.
•Reifenhäuser, A., Troisdorf, Germany
Rolls, Incorporated, Brooklyn, N. Y.
•Royle, John & Son, Paterson, N. J.
•Shaw, Francis & Co., Ltd., Manchester, Eng.
Sherman Rubber Machinery Co., Worcester, Mass.
•Stokes, F. J., Corp., Philadelphia, Pa.
•Welding Engineers, Inc., Norristown, Pa.
•Windsor, R. H., Ltd., Chessington, Eng.

FILM CUTTING MACHINES

Alsteele Engineering Works, Inc., Framingham, Mass.
Eastman Machine Company, Buffalo, N. Y.
•Hofmann & Schwabe, K. G., Krefeld, West Germany
Into-Roto Machine Co., Richmond, Va.
•Liberty Machine Co., Inc., Paterson, N. J.
Maimin, H., Co., Inc., New York
Mitts & Merrill, Saginaw, Mich.
Ruf Machine Co., Inc., New York
•Western Supplies Co., St. Louis, Mo.

FOAMING MACHINES

Dennis Chemical Co., St. Louis, Mo.
Guild Electronics, Inc., New York
Isocyanate Products, Inc., Wilmington, Delaware
Klauder, Weldon & Giles Co., Philadelphia, Pa.

FRAZING MACHINES

•Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
•Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Maplewood Companies, Livingston, N. J.
•Standard Tool Co., Leominster, Mass.

GRANULATING MACHINES

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Alsteele Engineering Works, Inc., Framingham, Mass.
American Pulverizer Co., St. Louis, Mo.
•Bailey, R. N., Co., Inc., New York
Ball & Jewell, Inc., Brooklyn, N. Y.
•Brositex Machine Co., Inc., New York
Colton, Arthur, Company, Detroit, Mich.
Comerio Encole S.P.A., Busto Arsizio, Italy
•Cumberland Engineering Co., Inc., Providence, Rhode Island
•DeMattia Machine & Tool Co., Clifton, N. J.
•Entoleter Division, Safety Industries, Inc., New Haven, Conn.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
•Hartig Engine & Machine Co., Hillside, N. J.
•Injection Molders Supply Co., Cleveland, Ohio
•M & N Modern Hydraulic Press, Clifton, N. J.
•Metals Disintegrating Co., Pulverizing Machinery Div., Summit, N. J.
Miller, Franklin P., & Son, Inc., East Orange, N. J.
•Modern Plastic Machinery Corp., Lodi, N. J.
•National Rubber Machinery Co., Akron, Ohio
•Negri, Bossi & Co., Milano, Italy
Rainville Co., Inc., Garden City, N. Y.
Sprout, Waldron & Co., Inc., Muncy, Pa.
•Taylor, Stiles, & Company, Riegelsville, N. J.
•Thoreson-McCosh, Inc., Detroit, Mich.
•Van Dorn Iron Works, Co., Cleveland, Ohio

HEAT SEALING MACHINES

A. High Frequency
B1. Thermal, Non-Portable
B2. Thermal, Portable

•Akron Presform Mold Co., Cuyahoga Falls, Ohio (*B2*)
Amsco Packaging Machinery, Inc., Long Island, N. Y. (*B1, B2*)
Barr Corp., Richmond Hill, N. Y. (*A*)
Callanan, J. A., Co., Chicago (*A, B1*)
•Cosmos Elec. Mach. Corp., N. Y.
•Cosom Engineering Corp., Mpls., Minn. (*A, B1*)
•D. & R. Plastic Welders Inc., Hazardville, Conn. (*B2*)
•Detroit Stamping Co., Detroit, Mich.
•Doven Mach. & Eng., Inc., Chicago
Electronic Processes Corp., San Francisco, Calif. (*A, B2*)
•Erdco Engineering Corp., Addison, Ill. (*A*)
Flodins Industrial, Lysekil, Sweden (*A*)
Girdler Company, Thermex Div., Louisville, Kentucky (*A*)
•Glenn Electric Heater Corp., Newark, N. J. (*A, B2*)
Guild Electronics, Inc., N.Y. (*A,B1,B2*)
International Plastic, New York (*A, B1*)
Kabar Manufacturing Corp., New York (*A*)

Kel-Min Company, Middlefield, Ohio (*B2*)
● Liberty Cutting Die Co., New York (*A*)
Mankato Paper Box Co., Mankato, Minn. (*B2*)
● Mayflower Electronic Devices, Inc., Littleferry, N. J. (*A*)
Plastic Welding Corp., Newark, N. J. (*A*)
Progressive Electronics Co., Inc., Lodi, N. J. (*A*)
● Radio Receptor Company, Inc., New York (*A*)
Reeve Electronics, Inc., Chicago, Ill. (*A*)
Richter, Frederic A., Chicago (*A*)
● Sealomatic Electronics Corp., Bklyn. N. Y. (*A, B1*)
Societe De L'electronique Francaise, Asnieres, France (*A*)
Trono Matic Machine, Mfg., Corp., New York (*A, B1*)
Weld Edge Plastics, Inc., Newark, N. J. (*A*)

IMPREGNATING MACHINES

● Akron Presform Mold Co., Cuyahoga Falls, Ohio
Applied Engineering Associates, Brooklyn, N. Y.
● Black-Clawson Co., Inc., Fulton, N. Y.
Diehl, G., Co., Strafford, Pa.
● Egan, Frank W., & Co., Somerville, N.J
● Faeco Machine Co., Inc., Paterson, N. J.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
General Engineering Co., Radcliffe Ltd., Bury Road, Radcliffe
● Hofmann & Schwabe K. G., Krefeld, West Germany
● Hull-Standard Corp., Abington, Pa.
Hunt, Rodney, Machine Co., Orange, Mass.
● Industrial Ovens Inc., Cleveland, Ohio
Multiplastics, Div. of Curd Enterprises, Addison, Ill.
● N.R.C. Equipment Corp., Newton, Mass.
Seal Cast Company, Inc., Philadelphia, Pa.
Sherman Rubber Machinery Co., Worcester, Mass.
● Stokes, F. J., Phila., Pa.
● Waldron, John, Corp., New Brunswick, N. J.

INJECTION MACHINES

(See also Presses, Hand Operated)

● Ambrogio Truilzi, Milan, Italy
● Battenfeld, Gebr., Meinerzhagen, West Germany
Becker & Van Hüllen, Krefeld
British Machine & Foundry Supplies Ltd., Port Washington, N. Y.
● Brositex Machine Co., Inc., New York
● Clifton Hydraulic Press Co., Clifton, N. J.
Crown Machine & Tool Company, Fort Worth, Texas
● Daniels, T. H. & J., Ltd., Gloucestershire, England
● DeMattia Machine & Tool Co., Clifton, N. J.
Dowding & Doll Limited, London
F.I.M.S.A.I., s.r.l., Milano, Italy
● Fellows Gear Shaper Co., Springfield, Vermont
Harvey, Guy P., & Sons Corp., Leominster, Mass.
● Hydraulic Press Mfg., Co., A Division of Keohring Co., Mount Gilead, Ohio
● Improved Machinery Inc., Nashua, N. H.
International Plastic, New York
● Karlton Machinery Corp., Chicago, Ill.
● Lester-Phoenix, Inc., Cleveland, Ohio
● Lewis Welding & Engineering Corp., Cleveland, Ohio
● Lombard Governor Corp., Ashland, Mass.
Machine Factory & Foundry, Ltd., Netstal Gl., Switzerland
Meiki Co., Ltd., Nagoya, Japan
● Moslo Machinery Co., Cleveland, Ohio
National Automatic Tool Co., Richmond, Indiana
● Negri, Bossi & Co., Milano, Italy
● Newark Die Company, Newark, N. J.
● Newbury Industries, Inc., Newbury, Ohio
Pasadena Hydraulics Inc., El Monte, Calif.
● Peco Machinery Sales (Westminster) Ltd., London, England
● Reed-Prentice Corp., Worcester, Mass.
● Shaw, Francis & Co., Ltd., Manchester, Eng.
● Simplomatic Mfg., Co., Chicago
Societe De L'electronique Francaise, Asnieres, France
● Standard Tool Co., Leominster, Mass.
● Stokes, F. J., Phila., Pa.
● Van Dorn Iron Works, Co., Cleveland, Ohio
● Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J.
● Windsor, R. H., Limited, Chessington, England

KNEADING AND MIXING MACHINES

● Abbe, Paul O. Inc., Little Falls, New Jersey
Applied Engineering Associates, Brooklyn, N. Y.
Baker Perkins, Inc., Saginaw, Mich.
Bullock-Smith Associates, New York
Comerio Encole S.P.A., Busto Arsizio, Italy
● Erie Plastics Company, Div. of Erie Iron & Supply Corp., Erie, Pa.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
● Hale & Kullgren Inc., Akron, Ohio
● Hommel, O., Co., Pitts., Pa.
● Lehmann, J. M., Company, Lyndhurst, N. J.
Patterson Foundry & Machine Company, E. Liverpool, Ohio
● Prodex Corp., Fords, N. J.
● Progressive Machine Co., Inc., Paterson, N. J.
Read Standard Division of Capitol Products Corp., York, Pa.
● Ross, Charles & Son, Bklyn, N. Y.
Sprout, Waldron & Co., Inc., Muncy, Pa.

LABELING AND DECORATING MACHINES

● Apex Machine Co., College Point, N. Y.
Archer Label Co., Los Angeles, Calif.
Automatic Methods, Inc., Elizabeth, N. J.
● Cosmos Electronic Machine Co., New York
Ebtwistle Manufacturing Corp., Providence, Rhode Island
International Marking Machine Co., New York
Ketchpel Engineering Co., West Englewood, N. J.
● Olsenmark Corp., New York
● Peerless Roll Leaf Co., Inc., Union City, N. J.
● Sun Chemical Corp., Long Island City, N. Y.

LIQUID BLASTING MACHINES

● Akron Presform Mold Co., Cayahoga Falls, Ohio
Pangborn Corp., Hagerstown, Maryland
Vapor Blast Mfg., Co., Milwaukee, Wis.

MASK WASHING MACHINES, AUTOMATIC

● Conforming Matrix Corp., Toledo Ohio

METAL SPRAYING MACHINES

Schori Process Division of Ferro-co Corp., Long Island, N. Y.

MOISTURE AND VOLATILE EXTRACTION MACHINES

Applied Engineering Associates, Brooklyn, N. Y.
Baker Perkins, Inc., Saginaw, Mich.
Goulding Mfg., Co., Saginaw, Mich.
● Litszler, C. A., Co., Inc., Cleveland, Ohio
● Prodex Corp., Fords, N. J.
Somerset Industrial Designs, Somerville, N. J.
● Stromes Systems, Inc., New York
Thermomat Co., Inc., Trenton, N. J.
● Welding Engineers, Inc., Norristown, Pa.

PAINT WIPING MACHINES

● Finish Engineering Co., Inc., Erie, Pa.
Maplewood Companies, Livingston, N. J.

POLISHING MACHINES (Flexible Shaft)

Wyzenbeek & Staff, Inc., Chicago

PULVERIZING MACHINES

● Abbe, Paul O. Inc., Little Falls, New Jersey
Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
American Pulverizer Co., St. Louis, Mo.
● Bailey, R. N., Co., Inc., New York
● Custom Machine & Design, Inc., Akron, Ohio
● Entoleter Division, Satety Industries Inc., New Haven, Conn.
Fisher Scientific Company, Pitts., Pa.
● Metals Disintegrating Co., Pulverizing Div., Summit, N. J.
Miller, Franklin P., & Son, Inc., East Orange, N. J.
Pulva Corp., Perth Amboy, N. J.
● Ross, Charles & Son, Company, Bklyn. N. Y.
Schutz-O'Neill Company, Minneapolis, Minn.
Sturtevant Mill Co., Boston, Mass.

ROLL EMBOSSING MACHINES

● Acromark Company (The), Elizabeth, New Jersey
● Apex Machine Co., College Point, N. Y.
● Black-Clawson Co., Inc., Fulton, N. Y.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

Chelsea Mills, Div. of Novelty BB-Co., New York
Dornbusch & Co., Krefeld, Germany
•Egan, Frank W., & Co., Somerville, N. J.
•Faeco Machine Co., Inc., Paterson, N. J.
•Farrel-Birmingham Company, Inc., Ansonia, Conn.
•Industrial Ovens, Inc., Cleveland, Ohio
Inta-Roto Machine Co., Richmond, Va.
International Engraving Corp., Cedar Grove, N. J.
Lembo Machine Works Inc., Paterson, N. J.
•Liberty Machine Co., Inc., Paterson, N. J.
•Progressive Machine Co., Inc., Paterson, N. J.
•Litzler, C. A., Co., Inc., Cleveland, Ohio
•Ringler-Dorin, Inc., New York
•Roehlen Engraving Works, Inc. Rochester, N. Y.
Sherman Rubber Machinery Co., Worcester, Mass.
•Sun Chemical Corp., Long Island City, N. Y.
Swan Machine Company, New York
•Waldron, John Corp., New Brunswick, N. J.

ROLLER COATING MACHINES

•Apex Machine Co., College Point, N. Y.
•Black-Clawson Co., Inc., Fulton, N. Y.
Dornbusch & Co., Krefeld, Germany
•Egan, Frank W., & Co., Somerville, N. J.
•Faeco Machine Co., Inc., Paterson N. J.
•Finish Engineering Co., Inc., Erie, Pa.
•Hofmann & Schwabe K. G., Krefeld, West Germany
Hunt, Rodney, Machine Co., Orange, Mass.
•Industrial Ovens Inc., Cleveland, Ohio
Inta-Roto Machine Co., Richmond, Va.
Ketchpel Engineering Co., West Englewood, N. J.
•Liberty Machine Co., Inc., Paterson, N. J.
•Litzler, C. A., Co., Inc., Cleveland, Ohio
Sherman Rubber Machinery Co., Worcester, Mass.
•Sun Chemical Corp., Long Island City, N. Y.
•Waldron, John Corp., New Brunswick, N. J.

ROTARY FINISHING MACHINES

Chelsea Mills, Div. of Novelty BB-Co., New York
Dornbusch & Co., Krefeld, Germany
•Hofmann & Schwabe K. G., Krefeld, West Germany
•Liberty Machine Co., Inc., Paterson, N. J.
Loed Chemical Corp., York, Pa.
Maplewood Companies, Livingston, N. J.
•Mercury Industries, Inc., Hillsdale, N. J.
•Robbins Plastic Machinery Corp. Elkhart, Ind.

SANDING MACHINES
(Wet and Dry)

Sommer & Maca Glass Machinery Co., Chicago
Stow Mfg., Co., Binghamton, N. Y.
Yates-American Machine Co., Beloit, Wisc.

SAWING MACHINES

A. Band Sawing
B. Circular Sawing
C. Hack Sawing
D. Jig Sawing
E. Radial Sawing
F. Panel Sawing

Boice-Crane Co., Toledo, Ohio (*A, B, D*)
Deluxe Saw & Tool Co., Louisville, Ky. (*B, E, F*)
Do All Co., Des Plaines, Ill. (*A*)
•Doven Mach. & Eng., Inc., Chicago
Heinrich, H. H., Co., New York (*B*)
•Reifenhäuser, A., Troisdorf, Germany (*F*)
•Robbins Plastic Machinery Corp., Elkhart, Ind. (*A, B*)
•Royle, John & Sons, Paterson, N. J. (*B*)
Stokes, F. J., Phila., Pa. (*B*)
Vern Emery Co., Sun Valley, Calif. (*B*)
Yates-American Machine Co., Beloit, Wisc. (*A, B, F*)

SCREENING, SEPARATING AND SIFTING MACHINES

Abbe Engineering Co., New York, N. Y.
Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
•Bailey, R. N., Co., Inc., New York
Bullock-Smith Associates, New York
Day, J. H., Company, Cincinnati, Ohio
•Lehmann, J. M., Co., Lyndhurst, N. J.
Loed Chemical Corp., York, Pa.
Patterson Foundry & Machine Company, E. Liverpool, Ohio
Read Standard Division of Capitol Products Corp., York, Pa.
Schutz-O'neill Company, Minneapolis, Minn.
Sprout, Waldron & Co., Inc., Muncy, Pa.
Sturtevant Mill Company, Dorchester, Boston, Mass.
•Taylor, Stiles & Co., Riegelsville, N.J.
•Thropp, Wm. R., & Sons, Div. of J. M. Lehmann Co., Inc., Lyndhurst, N. J.
•Tumb-L-Matic, Inc., St. Mary's St., Stamford, Conn.
Young Machinery Co., Muncy, Pa.

SHEET FORMING MACHINES

Abbott Plastic Machine, Chicago, Illinois
Auto-Vac Company, Bridgeport, Conn.
Borkland Mfg., Co., Maroin, Ind.
Brown Machine Co., Beaverton, Mich.
Chelsea Mills, Div. of Novelty BB-Co., New York
•Comet Industries, Franklin Park, Ill.
•Daniels, T. H. & J., Ltd., Gloucestershire, England
Delaware Valley Plastics Co., Phila., Pa.
•Doven Mach. & Eng., Inc., Chicago
Falge Engineering Corp., Bethesda, Md.
•Farrel-Birmingham Company, Inc., Ansonia, Conn.
Hydo-Chemie Limited, Zurich, Switzerland
•Modern Plastic Machinery Corp., Lodi, N. J.
•Negri, Bossi & Co., Milano, Italy
•Robbins Plastic Machinery Corp., Elkhart, Ind.
Societe De L'electronique Francaise, Asnieres, France
Thermomat Co., Inc., Trenton, N. J.
•Welding Engineers, Norristown, Pa.

SLITTING MACHINES

Abbott Plastic, Chicago, Illinois
Beck, Charles, Machine Corp., King of Prussia, Pa.
•Black-Clawson Co., Inc., Fulton, N. Y.
Cameron Machine Co., Brooklyn, N. Y.
•Cumberland Engineering Co., Inc., Providence, Rhode Island
Delaware Valley Plastics Co., Phila., Pa.
•Doven Mach. & Eng., Inc., Chicago
•Dusenbery, John, Company, Inc., Verona, N. J.
Eastman Machine Co., Buffalo, N. Y.
•Faeco Machine Co., Inc., Paterson, N.J.
•Hobbs Manufacturing Co., Worchester, Mass.
Inta-Roto Machine Co., Richmond, Va.
Lembo Machine Works Inc., Paterson, N. J.
Maimin, H., Co., Inc., New York
•Niagara Machine & Tool Works, Buffalo, N. Y.
•Robbins Plastic Machinery Corp., Elkhart, Ind.
Ruf Machine Co., Inc., New York
•Shaw, Francis & Co., Ltd., Manchester, Eng.
Swan Machine Company, New York
•Waldron, John, Corp., New Brunswick, N. J.

SLITTING AND MANGLING MACHINES

•Cumberland Engineering Co., Inc., Providence, Rhode Island
•Doven Mach. & Eng., Inc., Chicago

SPOOLING MACHINES FOR EXTRUSIONS

Al-Bo Industries, Bell Garden, Calif.
•Doven Mach. & Eng., Inc., Chicago
•Egan, Frank W., & Co., Somerville, N.J.
Falge Engineering Corp., Bethesda, Md.
•Foster & Allen, Inc., Garwood, N. J.
General Engineering Co., Radcliffe Ltd., Cury Road, Radcliffe
Heinrich, H. H., Co., New York
•Litzler, C. A., Co., Inc., Cleveland, Ohio
•National Rubber Machinery Co., Akron, Ohio
•Prodex Corp., Fords, N. J.
•Progressive Machine Co., Inc., Paterson, N. J.
•Riefenhäuser, A., Troisdorf, Germany
•Robbins Plastic Machinery Corp., Elkhart, Ind
Rolis Incorporated, Brooklyn, N. Y.
•Shaw, Francis & Co., Ltd., Manchester, Eng.

SPRAY PAINTING MACHINES

A. Automatic
B. Non-Automatic

Binks Manufacturing Co., Chicago (*A, B*)
•Conforming Matrix, Corp., Toledo, Ohio (*A, B*)
•DeVilbiss Co., Toledo, Ohio (*A, B*)
•Finish Engineering Co., Inc., Erie, Pa. (*A, B*)
Maplewood Companies, Livingston, N. J. (*A*)

•Indicates Advertiser.

● Sepanski & Assoc., Grand Rapids, Mich. (*A, B*)
● Thierica Studio, Inc., Grand Rapids, Mich. (*A, B*)

TAPPING MACHINES

Automatic Methods, Inc., Elizabeth, N. J.
Boice-Crane Co., Toledo, Ohio
Commander Mfg., Co., Chicago
Hamilton Tool Co., Hamilton, Ohio
Ketchpel Engineering Co., West Englewood, N. J.
● Mico Instrument Co., Cambridge, Mass.
National Automatic Tool Co., Richmond, Ind.
Procunier Safety Chuck Co., Chicago, Ill.

THERMOSETTING MOLDING AUTOMATIC MACHINES

● Automatic Molding Machine Co., Los Angeles
● B. I. P. Engineering Ltd., Sutton Coldfield, England
Baker Bros., Inc., Toledo, Ohio
● Battenfeld, Gebr., Meinerzhagen, West Germany
● Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio
● Lake Erie Engineering Corp., Kenmore, N. Y.
● Logan Engineering Co., Chicago, Ill.
● Logan Hydraulics, Inc., Chicago, Ill.
● Mercury Industries, Inc., Hillsdale, N. J.
● Stokes, F. J., Corp., Phila. Pa.

TUBE ROLLING MACHINES

General Engineering Co., Radcliffe Ltd., Cury Road, Radcliffe
● Hofmann & Schwabe K. G., Krefeld, West Germany
Spiral-Glas Pipe Co., New Brunswick, N. J.
Stone, S. G., Tube Machine Corp., Chicago

TUMBLING MACHINES

Abbe Engineering Co., New York, N. Y.
● Abbe, Paul O. Inc., Little Falls, New Jersey
● Erie Plastics Company, Div. of Erie Iron & Supply Corp., Erie, Pa.
● Injection Molders Supply Co., Cleveland Ohio
● Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
Load Chemical Corp., York, Pa.
● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Morse Mfg., Co., Inc., E. Syracuse, N. Y.
Rainville Co., Inc., Garden City, N. Y.
● Tumb-L-Matic, Inc., St. Mary's St., Stamford, Conn.
U. S. Stoneware Co., Akron, Ohio

VINYL (PLASTISOL) MOLDING MACHINES

A. Slush Molding
B. Rotational Molding

● Akron Presform Mold Co., Cuyahoga Falls, Ohio (*B*)
Applied Engineering Associates, Brooklyn, N. Y. (*A*)

● Indicates Advertiser.

Blue Co., E. B., Norwalk, Conn. (*A*)
● Mercury Industries, Inc., Hillsdale, N. J. (*B*)

WIRE COATING MACHINES

● Davis-Standard, Div. of Franklin Research, Mystic, Conn.
● Hartig Engine & Machine Co., Hillside, N. J.
Heinrich, H. H., Co., New York
Hermann Bertorff Maschinenbau-Anstalt G.M.B.H., Hannover, Germany
● Industrial Ovens Inc., Cleveland, Ohio
● Litzler, C. A., Co., Inc., Cleveland, Ohio
Meiki Co., Ltd., Nagoya, Japan
● National Rubber Machinery Co., Akron, Ohio
● Prodex Corp., Fords, N. J.
● Reifenhauser, A., Troisdorf, Germany
Rolls Incorporated, Brooklyn, N. Y.
● Royle, John & Sons, Paterson, N. J.
● Shaw, Francis & Co., Ltd., Manchester, Eng.

METAL DETECTORS, ELECTRONIC

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Radio Corp., of America, Camden, N. J.

MILLS, BALL OR PEBBLE

Abbe Engineering Co., New York, N. Y.
● Abbe, Paul O., Little Falls, N. J.
Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
Baker Perkins, Inc., Saginaw, Mich.
Fisher Scientific Company, Pittsburgh, Pa.
● Hommel, O., Co., Pittsburgh, Pa.
● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Morse Mfg., Co., Inc., E. Syracuse, N. Y.
Patterson Foundry & Machine Company, E. Liverpool, Ohio
U. S. Stoneware Co., Akron, Ohio

MILLS, ROLL

Abbe Engineering Co., New York, N. Y.
● Adamson United Company, Akron, Ohio
● Akron Presform Mold Co., Cuyahoga Falls, Ohio
Albert, L., & Son, Div. of Bellanca Corp., Trenton, N. J.
● Bolling, Stewart & Co., Inc., Cleveland
Comerio Encole S.P.A., Busto Arsizio, Italy
● Custom Machine & Design, Inc., Akron, Ohio
Day, J. H., Company, Cincinnati, Ohio
● Entoleter Division, Safety Industries Inc., New Haven, Conn.
● Erie Engine & Mfg. Company, Erie, Pa.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
Hermann Bertorff Maschinenbau-Anstalt GmbH., Hannover, Germany
● Lehmann, J. M., Company, Lyndhusrt, N. J.
Miller, Franklin P., & Son, Inc., East Orange, N. J.
● National Rubber Machinery, Akron, Ohio
Rolls Incorporated, Brooklyn, N. Y.
● Ross, Charles & Son, Bklyn, N. Y.
● Shaw, Francis & Co., Ltd., Manchester, Eng.
Sherman Rubber Machinery Co., Worcester, Mass.
Sprout, Waldron & Co., Inc., Muncy, Pa.
Sturtevant Mill Company, Dorchester, Boston, Mass.
● Thropp, Wm. R., & Sons, Div. of J. M. Lehmann Co., Inc., Lyndhurst, N. J.

MIXERS, BANBURY

● Bolling, Stewart & Co., Cleveland
● Custom Machine & Design, Inc., Akron, Ohio
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
Standard Electric Mfg., Co., Inc., West Berlin, N. J.

MIXERS, DRY COLORING & BLENDING

Abbe Engineering Co., New York
Abbe, Paul O., Inc., Little Falls, N. J.
● Bailey, R. N., Co., Inc., New York
Bullock-Smith Associates, New York
Colton, Arthur, Co., Detroit, Mich.
Day, J. H., Company, Cincinnati, Ohio
● Dunning & Boschert Press Co., Syracuse, N. Y.
● Entoleter Division, Safety Industries Inc., New Haven, Conn.
● Hommel, O., Pitts, Pa.
● Hull-Standard Corp., Abington, Pa.
● Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Miller, Franklin P., E. Orange, N. J.
Mose Mfg., Co., Inc., E. Syracuse, N. Y.
Patterson Foundry & Machine Company, E. Liverpool, Ohio
● Plastic Molders Supply Co., Inc., Fanwood, N. J.
Rainco Mfg., Co., Franklin, Pa.
Rainville, Co., Inc., Garden City, N. Y.
Rapids Machinery Co., Inc., Marion, Iowa
Read Standard Division of Capitol Products Corp., York, Pa.
● Ross, Charles & Son, Bklyn, N. Y.
Sprout, Waldron & Co., Inc., Muncy, Pa.
● Stokes, F. J., Corp., Phila., Pa.
Sturtevant Mill Company, Dorchester, Boston, Mass.
U. S. Stoneware Co., Akron, Ohio
Young Machinery Co., Muncy, Pa.

MIXERS, INTENSIVE INTERNAL

Abbe Engineering Co., New York, N. Y.
● Bolling, Stewart & Co., Cleveland
Bullock-Smith Associates, New York
Colton, Arthur, Co., Detroit, Mich.
Day, J. H., Company, Cincinnati, Ohio
● Entoleter Division, Safety Industries Inc., New Haven Conn.
● Farrel-Birmingham Company, Inc., Ansonia, Conn.
● Prodex Corp., Fords, N. J.
● Progressive Machine Co., Inc., Paterson, N. J.
● Ross, Charles & Son, Company, Bklyn, N. Y.
● Shaw, Francis & Co., Ltd., Manchester, Eng.
Standard Electric Mfg., Co., Inc., West Berlin, N. J.

MOLD TEMPERATURE CONTROLLERS

Baker Perkins, Inc., Saginaw, Mich.
● Barber-Colman Company, Wheelco Instruments Div., Rockford, Ill.
Devo Engineering, Inc., Caldwell, N. J.

Complete addresses of companies listed appear on pp. 1123-1149

●Improved Machinery Inc., Nashua, N. H.
●Industrial Manufacturing Corp., Indianapolis, Indiana
●Injection Molders Supply Co., Cleveland, Ohio
●Peco Machinery Sales (Westminster) Ltd., London, England
●Powers Regulator Co., Skokie, Ill.
Pyrometer Instrument Co., Inc., Bergenfield, N. J.
●Sarco Company, Inc., New York
●Sterling, Inc., Milwaukee, Wisc.
●Thoreson-McCosh, Inc., Detroit, Mich.
Vic Mfg. Co., Minneapolis, Minn.

POLYETHYLENE TREATERS FOR PRINTING

●Egan, Frank W., & Co., Somerville, N. J.
Inta-Roto Machine Co., Richmond, Va.
●Modern Plastic Machinery Corp., Lodi, N. J.
●National Rubber Machinery Co., Akron, Ohio
●Plastic Molding & Stamping Corp., Chicago
Process Equipment Co., Chicago

POWER UNITS, HYDRAULIC

Airoyal Co., Maplenroad, N. J.
Askania Regulator Co., Chicago
●B. I. P. Engineering Ltd., Sutton Coldfield, England
●Bolling, Stewart & Co., Cleveland
●Clifton Hydraulic Press Co., Clifton, N. J.
●Custom Machine & Design, Inc., Akron, Ohio
●Dake Corp., Grand Haven, Mich.
●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio
●Erie Engine & Mfg. Company, Erie, Pa.
●French Oil Mill Machinery Co., Piqua, Ohio
Goulding Mfg., Co., Saginaw, Mich.
Guild Electronics, Inc., New York
●Hull-Standard Corp., Abington, Pa.
●Hydraulic Press Mfg., Co., A Div. of Koehring Co., Mount Gilead, Ohio
Intercontinental Dynamics, Englewood, N. J.
●Karlton Machinery Corp., Chicago, Ill.
●M & N Modern Hydraulic Press, Clifton, N. J.
Masmillin Engineering Corp., Schiller Park, Ill.
Machine Factory & Foundry Ltd., Netstal GL., Switzerland
Pasadena Hydraulics Inc., El Monte, Calif.
●Robbins Plastic Machinery Corp., Elkhart, Ind.
Rolis Incorporated, Brooklyn, N. Y.
●Shaw, Francis & Co., Ltd., Manchester, Eng.
Sherman Rubber Machinery Co., Worcester, Mass.
Siempelkamp, G. & Co., Krefeld, Deutschland
Universal Hydr., Mchy., Co., Inc., New York
●Wood, R. D., Co., Phila, Pa.

PRESSES, ARBOR

●Acromark Company, Elizabeth, N. J.
Bellows Co., Akron, Ohio
●Dake Corp., Grand Haven, Mich.

●Indicates Advertiser.

●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio
Goulding Mfg., Co., Saginaw, Mich.
Greene & Arbor Press, Co., Nashua, N. H.
Guild Electronics, Inc., New York
Kabar Manufacturing Corp., New York
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J.
●Williams, White & Co., Moline, Ill.

PRESSES, CAKING

Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
●M & N Modern Hydraulic Press, Clifton, N. J.

PRESSES, COMPRESSION

A. Fully Automatic
B. Manual & Semi-Automatic

●Adamson United Company, Akron, Ohio (*A, B*)
Albert, L., & Son, Div. of Bellanca Corp., Trenton, N. J. (*A, B*)
●Ambrogio Truilzi, Milan, Italy (*A, B*)
●Atlas Hydraulics, Inc., Phila., Pa. (*A*)
Atlas-Sandt Corp., New York (*A*)
●Automatic Molding Machine Co., (*A, B*)
●B. I. P. Engineering, Ltd., Sutton Coldfield, England (*A, B*)
Baker Bros., Inc., Toledo, Ohio (*A*)
●Bolling, Stewart & Co., Cleveland (*B*)
Bradley & Turton, Ltd., Kidderminster, U. K. (*B*)
●Carver, Fred S., Inc., Summit, N. J. (*B*)
●Clifton Hydraulic Press Co., Clifton, N. J. (*A, B*)
●Custom Machine & Design, Inc., Akron, Ohio
●Dake Corp., Grand Haven, Mich. (*A, B*)
●Daniels, T. H. & J., Ltd., Gloucestershire, England (*B*)
●Davidson Kennedy Co., Atlanta, Ga. (*A, B*)
●Dunning & Boschert Press Co., Syracuse, N. Y.
●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio (*A, B*)
●Erie Engine & Mfg. Company, Erie, Pa. (*A, B*)
●Erie Foundry Company, Erie, Pa. (*A, B*)
Fjellman American, Inc., Joliet, Ill. (*A, B*)
●French Oil Mill Machinery Co., Piqua, Ohio (*B*)
Graf, John C., Phila., Pa. (*A, B*)
●Hale & Kullgren, Inc., Akron, Ohio (*A, B*)
Hermann Bertorff Maschinenbau-Anstalt GmbH., Hannover, Germany (*B*)
●Hull-Standard Corp., Abington, Pa. (*A, B*)
●Hydraulic Press Mfg. Co., A Div. of Koehring Co., Mount Gilead, Ohio (*A, B*)
●Improved Machinery, Inc., Nashua, N. H. (*B*)
●Karlton Machinery Corp., Chicago, Ill. (*B*)
Ketchpel Engineering Co., West Englewood, N. J. (*B*)
Knuth Engineering Company, Chicago, Ill. (*B*)
●Lake Erie Engineering Corp., Kenmore, N. Y. (*A, B*)
●Lawton, C. A., Co., De Pere, Wisc.
●Lewis Welding & Engineering Corp., Cleveland, Ohio (*B*)
●Lodge & Shipley, Cincinnati, Ohio (*B*)
●Logan Engineering Co., Chicago, Ill. (*A, B*)
●Logan Hydraulics, Inc., Chicago, Ill. (*A, B*)
●M & N Modern Hydraulic Press, Clifton, N. J.
Machine Factory & Foundry, Ltd., Netstal GL., Switzerland (*B*)
Pasadena Hydraulics, Inc., El Monte, Calif. (*A, B*)
Poinsettis Co., Inc., Pitman, N. J. (*B*)
Rolis Incorporated, Brooklyn, N. Y. (*B*)
●Shaw, Francis & Co., Ltd., Manchester, England (*B*)
Sherman Rubber Machinery Co., Worcester, Mass. (*B*)
Siempelkamp, G. & Co., Krefeld, Germany (*A, B*)
●Stokes, F. J., Corp., Phila., Pa. (*A, B*)
Verson Allsteel Press Company, Chicago, Ill. (*A, B*)
Wabash Metal Products Co., Wabash, Ind. (*B*)
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J. (*B*)
●Williams, White & Co., Moline, Ill. (*A, B*)
●Wood, R. D., Co., Phila., Pa. (*B*)

PRESSES, CONTINUOUS

●Erie Foundry Company, Erie, Pa.
Fjellman American, Inc., Joliet, Ill.
Hunt, Rodney, Machine Co., Orange, Mass.
Inta-Roto Machine Co., Richmond, Va.
●Karlton Machinery Corp., Chicago, Ill.
●M & N Modern Hydraulic Press, Clifton, N. J.

PRESSES, DEGATING

Barker-Davis Machine, Leominster, Mass.
Button Corp., New York
●Clifton Hydraulic Press Co., Clifton, N. J.
●Erie Foundry Company, Erie, Pa.
●Lawton, C. A., Co., De Pere, Wisc.
●M & N Modern Hydraulic Press, Clifton, N. J.
●Standard Tool Co., Leominster, Mass.

PRESSES, EMBOSSING

●Acromark Company, Elizabeth, N. J.
●Apex Machine Co., College Point, N. Y.
Atlas-Sandt Corporation, New York
●Clifton Hydraulic Press Co., Clifton, N. J.
●Dake Corp., Grand Haven, Mich.
●Doven Mach. & Eng., Inc., Chicago
●Elmes Engineering Division, Cincinnati, Ohio
●Erie Engine & Mfg. Company, Erie, Pa.
●Erie Foundry Company, Erie, Pa.
Falge Engineering Corp., Bethesda, Md.
●French Oil Mill Machinery Co., Piqua, Ohio
●Gane Bros. & Lane, Inc., Chicago
Inta-Roto Machine Co., Richmond, Va.
●Lake Erie Engineering Corp., Kenmore, N. Y.
●Laminating, Inc., Scranton, Pa.
●Lawton, C. A., Co., De Pere, Wisc.
Lembo Machine Works, Inc., Paterson N. J.
●Liberty Machine Co., Inc., Paterson, N. J.

●M & N Modern Hydraulic Press, Clifton, N. J.
●Olsenmark Corp., New York
Pasadena Hydraulics, Inc., El Monte, Calif.
●Peerless Roll Leaf Co., Inc., Union City, N. J.
●Ringler-Dorin, Inc., New York
●Sun Chemical Corp., Long Island City, N. Y.
Swan Machine Company, New York
●Western Supplies Co., St. Louis, Mo.
●Wood, R. D., Co., Phila., Pa.

PRESSES, FLEXOGRAPHIC PRINTING

American Type Founders Co., Elizabeth, N. J.
●Black-Clawson Co., Dilts Div., Fulton, N. Y.
Champlain Co., Bloomfield, N. J.
Haida Engineering Co., Long Island City, N. Y.
Heinrich, H. H. Co., New York
Inta-Roto Machine Co., Richmond, Va.
Manhasset Machine Co., Mineola, N. Y.
Mercury Engineering Corp., Milwaukee, Wis.
Paper Converting Machine Co., Green Bay, Wis.
Potdevin Machine Co., Teterboro, N. J.
●Rutherford Machinery Co., Div. Sun Chemical Corp., Long Island City, N. Y.
●John Waldron Corp., New Brunswick, N. J.
Wolverine Paper Converting Machinery Corp., Detroit

PRESSES, HAND OPERATED

A. *Compression*
B. *Injection*

●Atlas Hydraulics, Inc., Phila., Pa. (*A*)
●Battenfeld, Gebr., Meinerzhagen, West Germany (*A, B*)
Benwitt, Eric, Chicago (*A*)
Bradley & Turton, Ltd., Kidderminster, U. K. (*A*)
●Carver, Fred S., Inc., Summit, N. J.
●Clifton Hydraulic Press Co., Clifton, N. J. (*A, B*)
●Custom Machine & Design, Inc., Akron, Ohio
●Dake Corp., Grand Haven, Mich. (*A*)
●Daniels, T. H. & J., Ltd., Gloucestershire, England (*A*)
●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio (*A*)
●Erie Engine & Mfg. Company, Erie, Pa. (*A*)
●French Oil Mill Machinery Co., Piqua, Ohio (*A*)
Harvey, Guy P., & Son Corp., Leominster, Mass. (*B*)
●Hull-Standard Corp., Abington, Pa. (*A, B*)
Knuth Engineering Company, Chicago, Ill. (*A*)
●Logan Hydraulics, Chicago, Ill. (*A*)
Lommis Engineering & Mfg. Company, Newark, N. J. (*A*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*A*)
●Newbury Industries, Inc., Newbu Ohio

● Indicates Advertiser.

Pasadena Hydraulics, Inc., El Monte, Calif. (*A*)
Rolis Incorporated, Brooklyn, N. Y. (*A*)
●Simplomatic Mfg. Co., Chicago (*B*)
Somerset Industrial Designs, Somerville, N. J. (*A*)
Testing Machines, Inc., New York (*A*)
●Van Dorn Iron Works, Co., Cleveland, Ohio (*B*)
Wabash Metal Products Co., Wabash, Ind. (*A*)
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J. (*B*)
●Williams, White & Co., Moline, Ill. (*A*)
●Windsor, R. H., Ltd., Chessington, England (*B*)

PRESSES, HOBBING

Albert, L., & Son, Div. of Bellanca Corp., Trenton, N. J.
Becker & van Hüllen, Krefeld
●Clifton Hydraulic Press Co., Clifton, N. J.
●Dake Corp., Grand Haven, Mich.
●Daniels, T. H. & J., Ltd., Gloucestershire, England
●Detroit Stamping Co., Detroit, Mich.
●Dunning & Boschert Press Co., Syracuse, N. Y.
●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio
●Erie Foundry, Erie, Pa.
Graf, John C., Phila., Pa.
●Karlton Machinery Corp., Chicago, Ill.
●Lake Erie Engineering Corp., Kenmore, N. Y.
●Lawton, C. A., Co., De Pere, Wisc.
●Newbury Industries, Inc., Newbury, Ohio (*B*)
Verson Allsteel Press Company, Chicago, Ill.
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J.
●Williams, White & Co., Moline, Ill.
●Wood, R. D., Co., Phila., Pa.

PRESSES, INJECTION

(See Machines, Injection Molding and Presses, Hand Operated)

PRESSES, LAMINATING

A. *Thermosetting Sheet*
B. *Thermoplastic Sheet*

●Adamson United Company, Akron, Ohio (*A, B*)
Atlas Hydraulics, Inc., Phila., Pa. (*A*)
Becker & van Hüllen, Krefeld (*A, B*)
Blue, E. B., Co., S. Norwalk, Conn. (*B*)
●Carver, Fred S., Inc., Summit, N. J. (*A, B*)
●Clifton Hydraulic Press Co., Clifton, N. J. (*A, B*)
●Dake Corp., Grand Haven, Mich. (*A, B*)
●Dunning & Boschert Press Co., Syracuse, N. Y. (*A, B*)
●Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio (*A, B*)
●Erie Engine & Mfg. Company, Erie, Pa. (*A, B*)
●Erie Foundry Company, Erie, Pa. (*A, B*)
●Faeco Machine Co., Inc., Paterson, N. J. (*B*)
Fiellman American, Inc., Joliet, Ill. (*A, B*)
●French Oil Mill Machinery Co., Piqua, Ohio (*A, B*)
Glassoloid Corp., of America, Clifton, N. J. (*B*)
Graf, John C., Co., Phila., Pa. (*A, B*)
Guild Electronics, Inc., New York (*B*)
Hunt, Rodney, Machine Co., Orange, Mass. (*A, B*)
●Hydraulic Press Mfg. Co., A Div. of Koehring Co., Mount Gilead, Ohio (*A, B*)
Identification Service Corp., New York (*A, B*)
Inta-Roto Machine Co., Richmond, Va. (*A, B*)
●Karlton Machinery Corp., Chicago, Ill. (*A, B*)
●Lake Erie Engineering Corp., Kenmore, N. Y. (*A, B*)
●Lawton, C. A., Co., De Pere, Wisc. (*A, B*)
Lembo Machine Works, Inc., aterson, N. J. (*A, B*)
●Liberty Machine Co., Inc., Paterson, N. J. (*A, B*)
●Lodge & Shipley Co., Cincinnati, Ohio (*A, B*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*A, B*)
Meiki Co., Ltd., Nagoya, Japan (*A*)
●Modern Plastic Machinery Corp., Lodi, N. J. (*B*)
Pasadena Hydraulics, Inc., El Monte, Calif. (*A, B*)
Plastic Laminating Corp., Vaux Hall, N. J. (*A, B*)
Presco Plastics, Milwaukee, Wisc. (*B*)
Rolis Incorporated, Brooklyn, N. Y. (*A, B*)
Siempelkamp & Co., Krefeld, Germany (*A, B*)
Studebaker Hydraulic Products Company, Melrose Park, Ill. (*A*)
Testing Machines, Inc., New York (*A*)
Verson Allsteel Press Company, Chicago, Ill. (*A, B*)
Wabash Metal Products Co., Wabash, Ind. (*A, B*)
●Waldron, John Corp., New Brunswick, N. J. (*B*)
●Williams, White & Co., Moline, Ill. (*A, B*)
Willson Camera Co., Inc., Havertown, Pa. (*A, B*)
●Wood, R. D., Co., Phila., Pa. (*A, B*)

PRESSES, PLASTIC PRINTING

●Acromark Company, Elizabeth, N. J.
●Apex Machine Co., College Point, N. Y.
●Cosom Engineering Corp., Mpls., Minn.
Dornbusch & Co., Krefeld, Germany
●Detroit Stamping Co., Detroit, Mich.
● Faeco Machine Co., Inc., Paterson, N. J.
Heinrich, H. H., Co., New York
●Hofmann & Schwabe K. G., Krefeld, West Germany
Inta-Roto Machine Co., Richmond, Va.
International Marking Machine Co., New York
●Kingsley Stamping Machine Co., Hollywood, Calif.
Lembo Machine Works Inc., Paterson, N. J.
●Liberty Machine Co., Inc., Paterson, N. J.
●Olsenmark Corp., New York
●Ringler-Dorin, Inc., New York
Swan Machine Company, New York
●Waldron, John, Corp., New Brunswick, N. J.

Complete addresses of companies listed appear on pp. 1123-1149

PRESSES, PREFORMING

A. *Fibrous Material*
B. *Granular or Powder Materials*

●B. I. P. Engineering Ltd., Sutton Coldfield, England (*B*)
Bradley & Turton Ltd., Kidderminster, U. K. (*B*)
Colton, Arthur, Co., Detroit, Mich. (*B*)
●Daniels, T. H. & J., Ltd., Gloucestershire, England (*B*)
●Erie Foundry, Erie, Pa. (*A, B*)
Fiellman American, Inc., Joliet, Ill. (*A*)
Guild Electronics, Inc., New York (*B*)
●Lawton, C. A., Co., De Pere, Wisc. (*A, B*)
●Lodge & Shipley Co., Cincinnati, Ohio (*A, B*)
●Logan Engineering Co., Chicago, Ill. (*A, B*)
●Logan Hydraulics, Inc., Chicago, Ill. (*A, B*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*A, B*)
●Stokes, F. J., Corp., Phila., Pa. (*B*)
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J. (*B*)

PRESSES, ROLL LEAF AND HOT STAMPING

●Acromark Company, Elizabeth, N. J.
●Apex Machine Co., College Point, N. Y.
●Erie Foundry, Erie, Pa.
●Gane Bros. & Lane, Inc., Chicago
Griffin, Campbell, Hayes, Walsh, Inc., New York
●Kingsley Stamping Machine Co., Holtwood, Calif.
Matthews, Jas. H., Co., Pitts., Pa.
●Olsenmark Corp., New York
●Peerless Roll Leaf Co., Inc., Union City, N. J.
Swan Machine Company, New York
Swift, M. & Sons, Inc., Hartford, Conn.

PRESSES, TRANSFER MOLDING

●Adamson United Company, Akron, Ohio
●Ambrogio Truilzi, Milan, Italy
●B. I. P. Engineering Ltd., Sutton Coldfield, England
Baker Bros., Inc., Toledo, Ohio
●Battenfeld, Gebr., Meinerzhagen, W. Germany
Becker & van Hüllen, Krefeld
●Bolling, Stewart & Co., Cleveland
Bradley & Turton Ltd., Kidderminster, U. K.
●Clifton Hydraulic Press Co., Clifton, N. J.
●Dake Corp., Grand Haven, Mich.
●Daniels, T. H. & J., Ltd., Glouseshire, England
●Dunning & Boschart Press Co., Syracuse, N. Y.
●Elmes Engineering Division, Cincinnati, Ohio
●Erie Engine & Mfg. Company, Erie, Pa.
●Erie Foundry, Erie, Pa.
●French Oil Mill Machinery Co., Piqua, Ohio
Graf, John C., Co., Phila., Pa.
●Hydraulic Press Mfg., Co., A Div. of Koehring Co., Mount Gilead, Ohio
●Improved Machinery Inc., Nashua, N. H.
●Karlton Machinery Corp., Chicago
●Lake Erie Engineering Corp., Kenmore, N. Y.
●Lawton, C. A., Co., De Pere, Wisc.
●Logan Engineering Co., Chicago, Ill.
●Logan Hydraulics, Inc., Chicago, Ill.
●M & N Modern Hydraulic Press, Clifton, N. J.
Machine Factory & Foundry Ltd., Netstal Gl, Switzerland
Pasadena Hydraulics Inc., El Monte, Calif.
●Stokes, F. J., Corp., Phila., Pa.
Verson Allsteel Press Co., Chicago, Ill.
●Watson-Stillman Press Division, Farrel-Birmingham Company, Roselle, N. J.
●Williams, White & Co., Moline, Ill.
●Wood, R. D., Co., Phila., Pa.

PUMPS

A. *Coolant*
B. *Hydraulic*
C. *Vacuum*

Abbe Engineering Co., New York (*C*)
Allis-Chalmers Mfg., Co., Milwaukee, Wisc. (*A, B*)
American Air Compressor Co., North Bergen, N. J.
Beach-Russ Co., New York
Bradley & Turton Ltd., Kidderminster, U. K.
●Carver, Fred S., Inc., Summit, N. J.
Central Scientific Co., Chicago (*C*)
●Clifton Hydraulic Press Co., Clifton, N. J. (*B*)
Consolidated Electrodynamics Corp., Rochester Division, Rochester, N. Y. (*C*)
●Dunning & Boschert Press Co., Syracuse, N. Y. (B)
●Dusenbery, John, Company, Inc., Verona, N. J. (*B*)
●Elmes Engineering Div. of American Steel Foundries, Cincinnati, Ohio (*B*)
●Hull Standard Corp., Abington, Pa.
●N. R. C. Equipment Corp., Newton, Mass.
F. I. M. S. A. I., s. r. l., Milano, Italy
Fisher Scientific Company, Pitts., Pa. (*C*)
●French Oil Mill Machinery Co., Piqua, Ohio (*B*)
General Engineering Co., Radcliffe Ltd., Cury Road, Radcliffe (*C*)
Greer Industries, Inc., Jamaica, N. Y. (*B*)
●Hull-Standard Corp., Abington, Pa.
●Hydraulic Press Mfg., Co., A Div. of Koehring Co., Mount Gilead, Ohio (*B*)
●Karlton Machinery Corp., Chicago, Ill. (*B*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*B*)
Machine Factory & Foundry Ltd., Netstal Gl, Switzerland (*B*)
Meiki Co., Ltd., Nagoya, Japan (*B*)
●Mercury Industries, Inc., Hillsdale, N. J. (*C*)
Nash Engineering Company, Norwalk, Conn. (*C*)
●N. R. C. Equipment Corp., Naston, Mass. (*C*)
Oilgear Company, Milwaukee, Wisc. (*B*)
Pennsylvania Pump & Compressor Co., Easton, Pa. (*A, C*)
Quincy Compressor Co., Quincy, Ill. (*C*)
Ruthman Machinery Co., Cincinnati, Ohio (*A*)
●Shaw, Francis H Co., Ltd., Manchester, England (*C*)
●Sterling, Inc., Milwaukee, Wisc. (*A*)
Stokes, F. J., Corp. (*C*)
Wabash Metal Products Co., Wabash, Ind. (*B*)
●Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., Roselle, N. J.

RESIN MANUFACTURING PLANTS

●Hale & Kullgren, Inc., Akron, Ohio

SHEET PLASTIC FABRICATING MACHINES

(Bending, Creasing, Drawing, Folding, Glueing)

Borkland Mfg. Co., Marion, Ind.
●Comet Industries, Franklin Park, Ill.
Falge Engineering Corp., Bethesda, Md.
Graf, John C., Co., Phila., Pa.
●Liberty Machine Co., Inc., Paterson, N. J.
●National Rubber Machinery Co., Akron, Ohio
Plax Corp., Hartford, Conn.
●Portage Plastics Co., Portage, Wisc.
●Reifenhäuser, A., Troisdorf, Germany
Somerset Industrial Designs, Somerville, N. J.
Trono Matic Machine, Mfg., Corp., New York

USED AND REBUILT MACHINES

Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
American Air Compressor Co., North Bergen, N. J.
●Bolling, Stewart & Co., Cleveland
Bonwitt, Eric, Chicago
●Clifton Hydraulic Press Co., Clifton, N. J.
Guild Electronics, Inc., New York
●Johnson Machinery Co., Newark, N. J.
Kabar Manufacturing Corp., New York
●Lehmann, J. M., Company, Lyndhurst, N. J.
Lembo Machine Works Inc., Paterson, N. J.
●M & N Modern Hydraulic Press, Clifton, N. J.
Rolis Incorporated, Brooklyn, N. Y.
Sherman Rubber Machinery Co., Worcester, Mass.
Wabash Metal Products Co., Wabash, Ind.
Zenner, Justin, Chicago

●Indicates Advertiser.

EQUIPMENT

For related editorial information see p. 650, 890.

ACCUMULATORS

A. Air Ballasted
B. Hydropneumatic
C. Weight

- B. I. P. Engineering Ltd., Sutton Coldfield, England (*B*)
- Beltran Assoc., Brooklyn, N. Y. (*B*)
- Bradley & Turton Ltd., Kidderminster, U. K. (*C*)
- Dunning & Boschert Press Co., Inc., Syracuse, N. Y. (*C*)
- Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio (*A, B, C*)
- F. I. M. S. A. I. s. r. l., Milano, Italy (*B*)
- French Oil Mill Machinery Co., Piqua, Ohio (*B, C*)
- Graf, John C., & Co., Phila,, Pa. (*A, B, C*)
- Greer Industries, Inc., Jamaica, N. Y. (*B*)
- Industrial Ovens Inc., Cleveland, Ohio (*A, B, C*)
- Karlton Machinery Corp., Chicago (*B, C*)
- Miller Fluid Power Company, Melrose Park, Ill. (*A, B*)
- Machine Factory & Foundry Ltd., Ntstal/GL, Switzerland (*A, B*)
- Parker Appliance Company, Cleveland, Ohio (*B*)
- Vickers Incorporated, Administrative & Engineering Center, Detroit, Mich. (*B*)
- Watson-Stillman Press Div. Farrel-Birmingham Company, Inc., Roselle, N. J. (*B, C*)
- Wood, R. D., Co., Phila., Pa. (*B, C*)

AIR CONDITIONING EQUIPMENT

- Powers Regulator Co., Skokie, Ill.

AUTOCLAVES

- Adamson United Company, Akron, Ohio
- Beltran Assoc., Inc., Brooklyn, N. Y.
- Blaw-Knox Company, Chemical Plants Div., Pittsburgh, Pa.
- Bolling, Stewart, Co., Cleveland, Ohio
- Custom Machine & Design, Inc., Akron, Ohio
- Hull-Standard Corp., Abington, Pa.
- Seal Cast Co., Inc., Phila., Pa.
- Shaw, Francis & Co., Ltd., Manchester, Eng.

BARRELS, TUMBLING

- Abbe Engineering Co., New York
- Abbe, Paul O., Inc., Little Falls, N. J.
- American Hard Rubber Co., New York
- Erie Plastics Company, Div. of Erie Iron & Supply Corp., Erie, Pa.
- Haveg Industries, Inc., Wilmington, Del.
- Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
- Lacrinoid Products Ltd., Essex, England
- Lead Chemical Corp., York, Pa.
- Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
- Marine Plastics, Inc., Clinton, Mass.
- Plastic Molders Supply Co., Inc., Fanwood, N. J.
- Tumb-L-Matic, Inc., St. Mary's St., Stamford, Conn.
- U. S. Stoneware Co., Akron, Ohio

BEARINGS

(Ball, Cylindrical, Needle, Radial, Roller, Taper, Thrust)

- Haveg Industries, Wilmington, Del.
- Rollway Bearing Co., Syracuse, N. Y.
- Timken Roller Bearing Co., Canton, Ohio
- W.-L. Molding Co., Kalamazoo, Mich.

BOILERS

- Beltran Assoc., Inc., Brooklyn, N. Y.
- Eclipse Fuel Engineering Co., Rockford, Ill.
- Mears-Kane-Offeldt, Bridgeport, Pa.
- Vapor Heating Corp., Chicago

BUFFING AND POLISHING WHEELS

- Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
- Raybestos-Manhattan, Inc., Passaic, N. J.
- Sandman, Eli, Co., Worcester, Mass.

CALENDERING EQUIPMENT

- Adamson United Company, Akron, Ohio
- Beltran Assoc., Inc., Brooklyn, N. Y.
- Bolling Stewart, Co., Cleveland, Ohio
- Custom Machine & Design, Inc., Akron, Ohio
- Doven Mach. & Eng., Inc., Chicago
- Farrel-Birmingham Company, Inc., Ansonia, Conn.
- Heinrich, H. H. Co., New York
- Litzler, C. A., Co., Inc., Cleveland, Ohio
- Ross, Charles & Son Company, Bklyn, N. Y.
- Shaw, Francis & Co., Ltd., Manchester, Eng.

CONTROLLERS, AUTOMATIC FILM WIND-UP

- Askania Regulator Co., Chicago
- Egan, Frank W., & Co., Somerville, N. J.
- Electro-Devices, Inc., Paterson, N. J.
- Entwistle Manufacturing Corp., Providence, R. I.
- Faeco Machine Co., Paterson, N. J.
- Guild Electronics Inc., New York
- Progressive Machine Co., Paterson, N. J.
- Reliance Electric & Engineering Co., Cleveland, Ohio
- Roehlen Engraving Works, Inc., Rochester, N. Y.

CONTROLLERS

A. Flow
B. Pressure
C. Temperature
D. Time

- Airmatic Valve, Inc., Cleveland, Ohio (*B*)
- Askania Regulator Co., Chicago (*A, B, C, D*)
- B. I. P Engineering Ltd., Sutton Coldfield, England (*C*)
- Barber-Colman Company, Wheelco Instruments Division, Rockford, Ill. (*B, C, D*)
- Barksdale Valves, Los Angeles, Calif. (*A, B*)
- Beltran Assoc., Inc., Brooklyn, N. Y. (*C*)
- Clifton Hydraulic Press Co., Clifton, N. J. (*B*)
- Daniels, T. H. & J., Ltd., Gloucestershire, England (*D*)
- Eclipse Fuel Engineering Co., Rockford, Ill. (*B, C*)
- Egan, Frank, W., & Company, Somerville, N. J. (*C*)
- Electro-Tech Equipment Co., New York (*C, D*)
- Entwistle Manufacturing Corp., Providence, R. I. (*D*)
- F. I. M. S. A. I. s. r. l., Milano, Italy (*B*)
- Fischer & Porter Co., Hatboro, Pa. (*A, B, C*)
- Foxboro Company, Foxboro, Mass. (*A, B, C, D*)
- General Electric Co., Apparatus Sales Div., Schenectady, N. Y. (*B, C, D*)
- Glenn Electric Heater Corp., Newark, N. J. (*C, D*)
- Gorrell & Gorrell, Westwood, N. J. (*D*)
- Hanna Engineering Works, Chicago (*A*)
- Herbert Products, Inc., Woodhaven, N. Y. (*C*)
- Illionois Testing Laboratories, Inc., Chicago (*C*)
- Industrial Manufacturing Corp., Indianapolis, Ind. (*C*)
- Leeds & Northrup Company, Phila., Pa. (*C*)
- Leslie Co., Lyndhurst, N. J. (*A, B, C*)
- Machine Factory & Foundry Ltd., Ntstal/Gl, Switzerland (*A, B*)
- Mayer Refrigerating Engineers, Inc., Lincoln, N. J. (*C*)
- N. R. C. Equipment Corp., Newton, Mass. (*B*)
- Powers Regulator Co., Skokie, Ill. (*B, D*)
- Pyrometer Instrument Co., Inc., Bergenfield, N. J. (*C*)
- Sarco Co., Inc., New York (*B, C*)
- Sterling, Inc., Milwaukee, Wisc. (*C*)
- Taylor Instrument Companies, Rochester, (*A, B, C, D*)
- Thermo Electro Co., Inc., Saddle Brook, N. J. (*C*)
- Thoreson-McCosh, Inc., Detroit, Mich. (*C*)
- Thwing-Albert Instrument, Co., Phila., Pa. (*C*)
- Vickers Incorporated, Administrative & Engineering Center, Detroit, Mich. (*A, B*)

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149.

●West Instrument Corp., Chicago (*B, C*)
Weston Electric Instr., Corp., A. Sub. of Daystrom Inc., Newark, N. J. (*B, C*)
●Wiegand, Edwin L., Co., Pittsburgh, Pa. (*C*)

CONVEYORS

●R. N. Bailey & Co., Inc., New York
●Custom Machine & Design, Inc., Akron, Ohio
●Egan, Frank, W., & Company, Somerville, N. J.
●Entoleter Div., Safety Industries, Inc., New Haven, Conn.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
●Hartig Engine & Machine Co., Hillside, N. J.
Heinrich, H. H., Co., New York
Herbert Products, Woodhaven, N. Y.
Island Equipment Corp., L. I. C., New York
●Metals Disintegrating Co., Pulverizing Machinery Div., Summit, N. J.
●Mercury Industries, Inc., Hillsdale, N. J.
●National Rubber Machinery Co., Akron, Ohio
Rainco Mfg., Inc., Franklin, Pa.
Read Standard Div. of Capitol Products Corp., York, Pa.
●Robbins Plastic Machinery Corp., Elkhart, Ind.
Standard Conveyor Co., St. Paul, Minn.
●Stromes Systems, Inc. New York
Syntron Co., Homer City, Pa.
●Thoreson-McCosh, Inc., Detroit, Mich.
●Waldron, John, Corp., Brunswick, N. J.
●Whitlock, C. H., Associates, Oak Park, Mich.
Young Machinery Co., Muncy, Pa.

CYLINDERS

A. Pneumatic
B. Hydraulic
C. Heating—For Injection Molding Machines
D. Degassing, liquid

Airmatic Valve, Inc., Cleveland, Ohio (*A, B*)
Airoyal Company, Maplewood, N. J. (*A, B*)
Askania Regulator Co., Chicago (*B, D*)
Bradley & Turton Ltd., Kidderminster, U. K. (*B*)
●Clifton Hydraulic Press Co., Clifton, N. J. (*B, C*)
●Custom Machine & Design, Inc., Akron, Ohio (*A, B*)
●Dunning & Boschert Press Co., Inc., Syracuse, N. Y. (*B*)
Electro-Tech Equipment Co., New York (*C*)
F. I. M. S. A. I., Milano, Italy (*C*)
Ferridt Bros., Inc., Akron, Ohio (*C*)
Foxboro Company, Foxboro, Mass. (*A*)
Hanna Engineering Works, Chicago (*A, B*)
●Hydraulic Press Mfg., Co., Div. of Koehring Co., Mount Gilead, Ohio (*A, B*)
●Injection Molders Supply Co., Cleveland, Ohio (*C*)
●Lawton, C. A., Co., De Pere, Wisc. (*A, B*)
Lembo Machine Works, Inc., Paterson, N. J. (*B*)
●Miller Fluid Power Company, Melrose Park, Ill. (*A, B*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*B*)

●Indicates Advertiser.

Machine Factory & Foundry Ltd., Nestal.Gl, Switzerland (*B, C*)
Mead Specialties Co., Chicago (*A*)
Oilgear Company, Milwaukee, Wisc. (*B*)
Trono Matic Machine Mfg., Corp., New York (*A, B*)
Turcham Follower Mach., Co., Dearborn, Mich. (*B*)
●Vickers Incorporated, Engineering Center, Detroit, Mich. (*B*)

DIES, STEEL RULE, CLICKER & DINKER

●Akron Presform Mold Co., Coyahoga Falls, Ohio
●Liberty Cutting Die Co., New York
Richards, J. A., Company, Kalamazoo, Mich.
Societe De L'Electronique Francaise, Asnieres, France
Timeley Products Mfg., Co., Des Moines, Iowa
Todaro, S., Co., Buffalo, N. Y.
Trono Matic Machine Mfg., Corp., New York
●Western Supplies Co., St. Louis, Mo.

DIES, CUTTING

Independent Die & Supply Co., St. Louis, Mo.

DRIVES, VARIABLE SPEED

Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
Ball & Jewell, Inc., Brooklyn, N. Y.
●Custom Machine & Design, Inc., Akron, Ohio
●Electro-Devices, Inc., Paterson, N. J.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
●Farrel-Birmingham Company, Inc., Ansonia, Conn.
●Litzler, C. A., Co., Inc., Cleveland, Ohio
●Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
Oilgear Company, Milwaukee, Wisc.
Patron Transmission Co., Inc., New York
●Reliance Electric & Engineering Co., Cleveland, Ohio
Vickers Incorporated, Administrative & Engineering Center, Detroit, Mich.

DRYING AND PREHEATING EQUIPMENT

A. Electric, Gas, Hot Air, Steam Heat
B. Infrared

Allis-Chalmers Mfg., Co., Milwaukee, Wisc. (*A*)
Applied Engineering Associates, Brooklyn, N. Y. (*A*)
Beltran Assoc., Inc., Brooklyn, N. Y. (*B*)
Blue, E. B. Co., S. Norwalk, Conn. (*A, B*)
Blodgett, G. S., Co., Burlington, Vermont (*A*)
●Brositex Machine Co., New York (*A*)
Cleveland Process Co., Cleveland, Ohio (*A, B*)
Colton, Arthur, Company, Detroit, Mich. (*A*)
Dawson, F. C. Engineering Company, Canton, Mass. (*A*)
Fabbrica Prodotti Termoplastici, Carlo Pasquetti, Varese, Italy (*A*)
Falcon Equipment Company, New Brighton, Pa. (*A*)
●Fostoria Pressed Steel Corp., Fostoria, Ohio (*A, B*)
●Glenn Electric Heater Corp., Newark, N. J. (*A, B*)
Goulding Mfg., Co., Saginaw, Mich. (*A*)
Grieve-Hendry Co., Inc., Chicago (*A*)
Guild Electronics Inc., New York (*A*)
Herbert Products, Inc., Woodhaven, N. Y. (*A, B*)
●Hull-Standard Corp., Abington, Pa. (*A*)
Hynes Electric Heating Division, Turbine Equipment Co., Westfield N. J.
●Industrial Ovens, Inc., Cleveland, Ohio (*A, B*)
●Injection Molders Supply Co., Cleveland, Ohio (*A*)
Lembo Machine Works, Inc., Paterson, N. J. (*A*)
●Liberty Machine Co., Inc., Paterson, N. J. (*A, B*)
●Litzler, C. A., Co., Inc., Cleveland, Ohio (*A, B*)
●Lydon Bros., Inc., Hackensack, N. J. (*A, B*)
Michigan Oven Company, Detroit, Mich. (*A*)
Miskella Infra-Red Company, Cleveland, Ohio (*A, B*)
●Mercury Industries, Inc., Hillsdale, N. J. (*A, B*)
●National Rubber Machinery Co., Akron, Ohio (*A*)
North American Electric Lamp, St. Louis, Mo. (*B*)
●Peco Machinery Sales Ltd., London, England (*A*)
Proctor & Schwartz, Inc., Phila., Pa. (*A*)
Radiant Heat Enterprises, Inc., Short Hills, N. J. (*A, B*)
Rainville Co., Inc., Garden City, N. Y. (*A*)
●Shaw, Francis & Co., Ltd., Manchester, Eng. (*B*)
Societe De L'Electronique Francaise, Asnieres, France (*A*)
Somerset Industrial Designs, Inc., Somerville, N. J. (*A, B*)
●Stokes, F. J. Corp., Phila., Pa.
●Stromes Systems, Inc., N. Y. (*A*)
●Thoreson-McCosh, Inc., Detroit, Mich. (*A*)
●Waldron, John, Corp., New Brunswick, N. J. (*A, B*)
●Whitlock, C. H., Associates, Oak Park, Mich. (*A*)
●Wiegand, Edwin L., Co., Pittsburgh, Pa. (*A, B*)
Wyssmont Co., Inc., Long Island City, N. Y. (*A*)

FILTERS AND OIL PURIFIERS

Airmatic Valve, Inc., Cleveland, Ohio
Filtron Company, Inc., Flushing, N. Y.
Haveg Industries, Inc., Wilmington, Del.
●Marvel Engineering Company, Chicago
Pyramid Screen Corp., Brooklyn, N. Y.

FLAME SPRAYING, PLASTIC

(*Equipment*)

●American Agile Corp., Maple Hts., Ohio
Schori Process, Div. of Ferro-co Corp., Long Island City, N. Y.

FLOW METERS

Askania Regulator Co., Chicago
Fischer & Porter Co., Hatboro, Pa.
Foxboro Company, Foxboro, Mass.
Neptune Meter Company, New York

● Taylor Instrument Companies, Rochester, N. Y.

GAGES, PLUG AND THREAD

Pratt & Whitney Co., Inc., West Hartford, Conn.
Size Control Co., Chicago

GAGES, RECORDING

Askania Regulator Co., Chicago
● Barber-Colman Company, Wheelco Instruments Division, Rockford, Ill.
Fischer & Porter Co., Hatboro, Pa.
Foxboro Company, Foxboro, Mass.
Industrial Nucleonics Corp., Columbus, Ohio
Isotope Products, Buffalo, N. Y.
● N. R. C. Equipment Corp., Newton, Mass.
● Powers Regulator Co., Skokie, Ill.
Pratt & Whitney Co., Inc., West Harford, Conn.
● Taylor Instrument Companies, Rochester, N. Y.
● West Instrument Corp., Chicago
Weston Electrical Instr., Corp., A. Sub. of Daystrom Inc., Newark, N. J.

GAGES, THICKNESS

(for moving web)

Electronics Div., Curtiss-Wright, Carlstadt, N. J.
Foxboro Company, Foxboro, Mass.
Industrial Nucleonics Corp., Columbus, Ohio
Isotope Products, Buffalo, N. Y.
Pratt & Whitney Co., Inc., West Hartford, Conn.
Tracerlab, Inc., Boston, Mass.

GENERATORS, STEAM

● Pantex Mfg. Corp., Pawtucket, R. I.

HANDLING DEVICES FOR PLASTIC SHEET AND FILM

(Expanders, Guiders, Straighteners, Batchers, Sheeters, Etc.)

● Dusenbery, John, Company, Inc., Verona, N. J.
● Faeco Machine Co., Inc., Paterson, N. J.
Goulding Mfg., Co., Saginaw, Mich.
Guild Electronics Inc., New York
● Hobbs Manufacturing Co., Worcester, Mass.
● Industrial Ovens Inc., Cleveland, Ohio
Lembo Machine Works, Inc., Paterson, N. J.
● Liberty Machine Co., Inc., Paterson, N. J.
● Litzler, C. A., Co., Inc., Cleveland, Ohio
Mount Hope Machinery Co., Taunton, Mass.
● National Rubber Machinery Co., Akron, Ohio
● Peco Machinery Sales, Ltd., London, England
● Peterson & Sons Die Co. A. W. New York
● Progressive Machine Co. Paterson, N. J.
● Robbins Plastic Machinery Corp., Elkhart, Ind.
● Shaw, Francis & Co., Ltd., Manchester Eng.
Trono Matic Machine Corp., New York
● Waldron, John, Corp., New Brunswick, N. J.
● Welding Engineers, Inc., Norristown, Pa.

HEATING EQUIPMENT

(For Molds and Molding Machines)

Beltran Assoc., Inc., Brooklyn, N. Y.
Callanan, J. A. Co., Chicago
Cleveland Process Co., Cleveland, Ohio
● Clifton Hydraulic Press Co., Clifton, N. J.
Cuming, M. A. & Co., Inc., New York
● Doven Mach. & Eng., Inc., Chicago
Eclipse Fuel Engineering Co., Rockford, Ill.
Falcon Equipment Company, New Brighton, Pa.
● Fostoria Pressed Steel Corp., Fostoria Ohio
● General Electric Co., Apparatus Sales Div., Schenectady, N. Y.
● Glenn Electric Heater Corp., Newark, N. J.
Guild Electronics Inc., New York
Herbert Products, Inc., Woodhaven, N. Y
Hynes Electric Heating Division, Turbine Equipment Co., Westfield, N. J.
● Industrial Heater Co., Inc., New York
● Industrial Manufacturing Corp., Indianapolis, Indiana
Industron Corp., Newton Heights, Mass.
● Injection Molders Supply Co., Cleveland, Ohio
● Mercury Industries, Inc., Hillsdale, N. J.
● National Rubber Machinery Co., Akron, Ohio
● Powers Regulator Co., Skokie, Ill.
● Robbins Plastic Machinery Corp., Elkhart, Ind.
● Sarco Co., Inc., New York
Societe De L'Electronique, Francaise, Asnieres
Somerset Industrial Designs, Inc., Somerville, N. J.
● Sterling, Inc., Milwaukee, Wisc.
● Thermel Inc., Franklin Pk., Ill.
● Thoreson-McCosh, Inc., Detroit, Mich.
Todaro, S., & Co., Buffalo, N. Y.
● Watlow Electric Mfg., Co., St. Louis, Mo.
● Wiegand, Edwin L., Co., Pittsburgh, Pa.

HEAT SEALING EQUIPMENT

(See also, Machines, Heat Sealing)

Amaco Packaging Machinery, Inc., Long Island City, N. Y.
Chaffe, Ralph & Company, San Francisco, Calif.
● Cosmos Electronic Machine Co., New York
● D & R Plastic Welders Inc., Hazardville, Conn.
● Erdco Engineering Corp., Addison, Ill.
Girdler Company, Thermex Div., Louisville, Ky.
● Glenn Electric Heater Corp., Newark, N. J.
Guild Electronics Inc., New York
● Industrial Heater Co. Inc., New York
Kabar Manufacturing Corp., New York
Kal-Min Company, Middlefield, Ohio
● Liberty Cutting Die Co., New York
Mankato Paper Box Co., Mankato, Minn.
● Mayflower Electronic Devices, Inc., Littleferry, N. J.
● Peterson, A. W. & Sons Die Co., New York
Plastic Welding Corp., Newark, N. J.
● Radio Receptor Company, New York
Reeve Electronics, Inc., Chicago
● Sealomatic Electronics Corp., Bklyn, N. Y.
Societe De L'Electronique, Francaise, Asnieres
Trono Matic Machine, Corp., New York
Weld Edge Plastics, Inc., Newark, N. J.

HIGH FREQUENCY PREHEATING EQUIPMENT

Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
Beltran Assoc., Inc., Brooklyn, N. Y.
Girdler Company, Thermex Div., Louisville, Ky.
Guild Electronics Inc., New York
Industron Corp., Newton Heights, Mass.
Plastic Welding Corp., Newark, N. J.
● Radio Receptor Company, Inc., New York
Reeve Electronics, Inc., Chicago
Societe De L'Electronique, Asnieres, France

HYDRAULIC POWER SYSTEMS

Airoyal Company, Mapleroad, N. J.
● B. I. P. Engineering Ltd., Sutton Coldfield, England
● Clifton Hydraulic Press Co., Clifton, N. J.
● Custom Machine & Design, Inc., Akron, Ohio
Devco Engineering Inc., Caldwell, N. J.
● Dusenbery, John, Company, Inc., Verona, N. J.
● Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio
● French Oil Mill Machinery Co., Piqua, Ohio
Goulding Mfg., Co., Saginaw, Mich.
Graf, John C., & Co., Phila., Pa.
Guild Electronics Inc., New York
● Hull-Standard Corp., Abington, Pa.
● Hydraulic Press Mfg., Co., Div. of Koehring Co., Mount Gilead, Ohio
● Karlton Machinery Corp., Chicago
● M & N Modern Hydraulic Press, Clifton, N. J.
Machine Factory & Foundry Ltd., Netstal. Gl, Switzerland
Oilgear Company, Milwaukee, Wisc.
Rollo Incorporated, Brooklyn, N. Y.
Siempelkamp, G. & Co., Krefeld, Deutschland
Turchan Follower Mach., Co., Detroit
● Vickers Incorporated, Administrative & Engineering Center, Detroit, Mich.
Wabash Metal Products Co., Wabash, Ind.
● Wood, R. D., Co., Phila., Pa.

KETTLES, RESIN

Blaw-Knox Company, Chemical Plants Div., Pittsburgh, Pa.
Falcon Equipment Co., New Brighton, Pa.
● Hull-Standard Corp., Abington, Pa.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149.

LINERS, EXTRUDING MACHINE CYLINDERS

●Custom Machine & Design, Inc., Akron, Ohio
●Egan, Frank, W. & Company, Somerville, N. J.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy
●Hale & Kullgren Inc., Akron, Ohio
●Industrial Research Laboratories, Los Angeles

LUBRICATING SYSTEMS CENTRALIZED

Lincoln Engineering Co., St. Louis, Mo.

MARKING EQUIPMENT

A. *Roll Leaf Stamping*
B. *Branding*
C. *Engraving*
D. *Printing (for molded parts only)*

●Ackerman-Gould Company, New York (*A, B, C, D*)
●Acromark Company, Elizabeth, N. J. (*A, B, C, D*)
●Apex Machine Co., College Point, N. Y. (*A, D*)
Entwistle Manufacturing Corp., Providence, R. I. (*B, D*)
●Garten, George, Machine Co., Racine, Wisc. (*C*)
International Engraving Corp., Cedar Grove, N. J. (*C*)
International Marking Machine, New York (*D*)
●Kingsley Stamping Machine Co., Hollywood, Calif (*A, D*)
●Matthews, Jas. H. & Co., Pitts., Pa. (*B, C*)
●Mico Instrument Co., Cambridge, Mass. (*C*)
Markem Machine Co., Keene, N. H. (*A, B, D*)
●Olsenmark Corp., New York (*A, B, D*)
Preis, H. P., Engraving Machine Co., Hillside, N. J. (*C*)
Swan Machine Co., New York (*A, D*)
Technicraft Co., Boston, Mass. (*C*)

MOLD COMPONENTS STANDARD STOCK

Damon Tool & Engineering Co., Chicago
●Detroit Mold Engineering Co., Detroit
●Newark Die Company, Newark, N. J.
Southern Tool Mfg., Co., Winston, N. C.
●Van Dorn Iron Work, Cleveland, Ohio

MOLDS AND DIES

(*See Specialized Service*)

MOTORS

Allen, Louis, Co., Stewart, Wisc.
Allis-Chalmers Mfg., Co., Milwaukee, Wisc.
Electro-Devices, Inc., Paterson, N. J.
●General Electric Co., Apparatus Sales Div., Schenectady, N. Y.
●Reliance Electric & Engineering Co., Cleveland, Ohio
●Vickers Incorporated, Administrative & Engineering Center, Detroit, Mich.

NOZZLES, FOR INJECTION MOLDING MACHINES

●Clifton Hydraulic Press Co., Clifton, N. J.
F. I. M. S. A. I. s. r. l., Milano, Italy
Ferriot Bros., Inc., Akron, Ohio
Industrial Engineering Service, South Easton, Mass.
●Injection Molders Supply Co., Cleveland, Ohio
Machine Factory & Foundry Ltd., Netstal/GL, Switzerland
●Newark Die Company, Newark, N. J.
●Standard Tool Co., Leominster, Mass.

OVENS

(*See Drying and Preheating Equipment*)

Inta-Roto Machine Co., Richmond, Va.
Michigan Oven Company, Detroit, Mich.

PIGMENTS, METALLIC

Aluminum Co. of America, Pittsburgh, Pa.
Metals Disintegrating Co., Inc., Elizabeth, N. J.
Reynolds Metals Co., Louisville, Ky.

PLATENS, PRESS

(*Electric and Steam*)

●Adamson United Company, Akron, Ohio
Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
●B. I. P. Engineering Ltd., Sutton Coldfield, England
Becker & van Hüllen, Krefeld, Ger.
Beltran Assoc., Inc., Brooklyn, N. Y.
●Bolling, Stewart, Co., Cleveland, Ohio
Bradley & Turton, Kidderminster, U. K.
●Carver, Fred S., Inc., Summit, N. J.
●Clifton Hydraulic Press Co., Clifton, N. J.
Cuming, M. A. & Co., Inc., New York
●Custom Engineering Co., Erie, Pa.
●Custom Machine & Design, Inc., Akron, Ohio
●Daniels, T. H. & J., Ltd., Gloucestershire, England
●Doven Mach. & Eng., Inc., Chicago
Entwistle Manufacturing Corp., Providence, R. I.
Falcon Equipment, New Brighton, Pa.
Fjellman American, Inc., Joliet, Ill.
●French Oil Mill Machinery Co., Piqua, Ohio
Graf, John C. & Co., Phila., Pa.
Guild Electronics Inc., New York
●Hale & Kullgren Inc., Akron, Ohio
●Hull-Standard Corp., Abington, Pa.
Industrial Engineering Service, South Easton, Mass.
●Karlton Machinery Corp., Chicago
●Lake Erie Engineering Corp., Kenmore, N. Y.
●Lawton, C. A., Co., De Pere, Wisc.
Machine Factory & Foundry Ltd., Netstal/Gl., Switzerland
●National Rubber Machinery Co., Akron, Ohio
Pasadena Hydraulics, El Monte, Calif.
●Roehlen Engraving Works, Rochester, N. Y.
●Shaw, Francis & Co., Ltd., Manchester, Eng.
Siempelkamp, G. & Co., Krefeld, Deutschland
Studbaker Hydraulic Products Co., Melrose Park, Ill.
Trenomatic Machine, Mfg., Corp., New York
Universal Hydraulic Mchy., Co., Inc., New York
Wabash Metal Products Co., Wabash, Ind.
●Williams, White & Co., Moline, Ill.
Willson Camera Co., Inc., Havertown, Pa.
●Wood, R. D., Co., Phila., Pa.

PLATES, for COMPRESSION MOLDING

(*Polishing, Laminating, etc.*)

●Carver, Fred S., Inc., Summit, N. J.
●Chromium Corporation of America, New York
Fabrite Metals Corp., Brooklyn, N. Y.
Pasadena Hydraulics, Inc., El Monte, Calif.
Siempelkamp, G. & Co., Krefeld, Deutschland
Wabash Metal Products Co., Wabash, Ind.
Willson Camera Co., Inc., Havertown, Pa.

PREHEATING EQUIPMENT

(*See Drying, Heating, High Frequency Equipment*)

PROPORTIONING (and metering) SYSTEMS

●Akron Presform Mold Co., Cuyahoga Ohio
Applied Engineering Associates, Brooklyn, N. Y.
●Barber-Colman Company, Wheelco Instruments Division, Rockford, Ill.
Devco Engineering Inc., Caldwell, N. J.
Diehl, G., Mateer Co., Strafford, Wayne, Pa.
Electro-Devices, Inc., Paterson, N. J.
Fischer & Porter Co., Hatboro, Pa.
●Mercury Industries, Inc., Hillsdale, N. J.

PYROMETERS

Barber-Colman Company, Wheelco Instruments Division, Rockford, Ill.
●Cambridge Instrument Co., New York
Electro-Tech Equipment Co., New York
Foxboro Company, Foxboro, Mass.
●General Electric Co., Apparatus Sales Div., Schenectady, N. Y.
●Glenn Electric Heater Corp., Newark, N. J.
Illinois Testing Laboratories, Inc., Chicago
Leeds & Northrup Company, Phila., Pa.
Pyrometer Instruments Co., Inc., Bergenfield, N. J.
Testing Machines, Inc., New York
●Therma Electric Co., Inc., Saddle Brook, N. J.
Thwing-Albert Instrument Co., Phila., Pa.
Wabash Metal Products Co., Wabash, Ind.
●West Instrument Corp., Chicago
Weston Electrical Instr., Corp. A. Sub, of Daystrom Inc., Newark, N. J.

REWINDING EQUIPMENT

●Black-Clawson Co., Inc., Fulton, N. J.
●Dusenbery, John, Company, Inc., Verona, N. J.
●Egan, Frank, W. & Company, Somerville, N. J.
Entwistle Manufacturing Corp., Providence, R. I.
Goulding Mfg., Co., Saginaw, Mich.

●Indicates Advertiser.

Guild Electronics Inc., New York
Heinrich, H. H., Co., New York
●Hobbs Manufacturing Co., Worcester, Mass.
●Industrial Ovens Inc., Cleveland, Ohio
Inta-Roto Machine Co., Richmond, Va.
Johnstone Engineering & Machine Co., Parkesburg, Pa.
Lembo Machine Works, Inc., Paterson, N. J.
●Litzler, C. A., Co., Cleveland, Ohio
●Progressive Machine Co., Inc., Paterson, N. J.
Rolls Incorporated, Brooklyn, N. Y.
Vern Emery Co., Sun Valley, Calif.
●Waldron, John, Corp., New Brunswick, N. J.

ROLLS

A. *Calendering and Compounding*
B. *Embossing*
C. *Printing*

●Ackerman-Gould, New York (*B*)
●Acromark Co., Elizabeth, N. J. (*C*)
●Adamson United Company, Akron, Ohio (*A*)
●Apex Machine Co., College Point, N.Y. (*B, C*)
●Bolling, Stewart, Co., Cleveland, Ohio (*A*)
Carpenter, L. E. & Co., Wharton, N. J. (*B*)
Chelsea Mills, Div. of Novelty, BB-Co., New York (*B*)
●Custom Machine & Design, Inc., Akron, Ohio (*A, B, C*)
●Cylinder Mfg., Co., Hawthorne, N. J. (*A*)
●Doven Mach. & Eng., Inc., Chicago (*A*)
●Faeco Machine Co., Inc., Paterson, N. J. (*B, C*)
●Farrel-Birmingham Company, Inc., Ansonia, Conn. (*A, B*)
Greer Industries, Inc., Jamaica, N. Y. (*A, B, C*)
Haveg Industries, Inc., Wilmington, Del. (*A*)
●Industrial Ovens, Inc., Cleveland, Ohio (*A*)
Inta-Roto Machine Co., Richmond, Va. (*B, C*)
International Engraving Corp., Cedar Grove, N. J. (*A, B, C*)
●Lehmann, J. M., Co., Inc., Lyndhurst, N. J. (*A*)
Lembo Machine Works, Inc., Paterson, N. J. (*B, C*)
●Production Metal Prod. Co., Inc., Chicago, Ill. (*A*)
Raybestos-Manhattan, Inc., Passaic, N. J. (*C*)
●Ringler-Dorin, Inc., New York (*B*)
●Robbins Plastic Machinery Corp., Elkhart, Ind. (*A*)
●Roehlen Engraving Works, Rochester, N. Y. (*B, C*)
●Ross, Charles & Son, Company Bklyn, N. Y. (*A*)
Ruhrstahl Aktiengesellschaft Henrichshütte, Hattingenruhr, Western Germany (*A*)
●Shaw, Francis & Co., Ltd., Manchester, Eng.
Stowe-Woodward, Inc., Newton Upper, Mass. (*B, C*)
Swan Machine Co., New York, (*B, C*)
●Waldron, John, Corp., New Brunswick, N. J. (*A, B*)
Wolverine Paper Converting Machinery Corp., Detroit, Mich. (*C*)

SCALES

(Checkweighing, Compounding, Weighing)

Detecto Scales, Inc., Bklyn, N. Y.
Electro-Tech Equipment Co., New York
Exact Weight Scales Co., Columbus, Ohio
Toledo Scale Co., Toledo, Ohio
Torsion Balance Co., Clifton, N. J.
Wabash Metal Products Co., Wabash, Ind.

SQUARING SHEARS

●Niagara Machine & Tool Works, Buffalo, N. Y.

STATIC ELIMINATORS

Herbert Products, Inc., Woodhaven, N. Y.

TABLES, ELEVATING

●Adamson United Company, Akron, Ohio
Albert, L. & Son, Div. of Bellanca Corp., Trenton, N. J.
Backer & van Hüllen, Krefeld
●Bolling, Stewart, Co., Cleveland, Ohio
●Clifton Hydraulic Press Co., Clifton, N. J.
●Custom Machine & Design, Inc., Akron, Ohio
●French Oil Mill Machinery Co., Piqua, Ohio
Hamilton Tool Co., Hamilton, Ohio

TESTING APPARATUS

A. *Abrasion*
B. *Accelerated Weathering*
C. *Conditioning Cabinets*
D. *Electrical*
E. *Flow*
F. *Hardness*
G. *Heat Distortion*
H. *Impact*
I. *Ovens*
J. *Strength*
K. *Visual Color Matching*
L. *Miscellaneous*

●Aetna Electronics Corp., Carle Place, L. I., New York (*D, L*)
●Atlas Electric Devices Co., Chicago (*B, L*)
Central Scientific Company, Chicago (*J*)
Clark Instrument, Inc., Dearborn, Mich. (*F*)
Custom Scientific Instruments, Inc., Kearny, N. J. (*A, L*)
Dice, J. W., Company, Englewood, N. J. (*D, L*)
Electro-Tech Equipment Co., New York (*D, I*)
Entwistle Manufacturing Corp., Providence, R. I. (*D*)
Fischer & Porter Co., Hatboro, Pa. (*E*)
Fisher Scientific Company, Pitts., Pa. (*I, K*)
●Fostoria Pressed Steel Corp., Fostoria, Ohio (*I*)
Gaunes Engineering Co., Chicago (*H*)
●General Electric Co., Apparatus Sales Div., Schenectady, N. Y. (*D, K*)
Guild Electronics Inc., New York (*D*)
Knuth Engineering Co., Chicago (*F, J*)
Leeds & Northrup Company, Phila., Pa. (*D*)
Macbeth Corp., Newburgh, N. Y. (*K*)
Marine Plastics, Clinton, Mass. (*D*)
●Microcell, Ltd., Low Dow, England (*D*)
Olsen, Tinius Co., Willow Grove, Pa.
●Scott Testers, Inc., Providence, R. I. (*A, C, H, I, J, L*)
Soiltest, Inc., Chicago (*I, J*)
Tenny Engineering, Inc., Union, N. J. (*B, C*)
Testing Machines, Inc., New York (*A, C, D, E, F, G, H, I, J, K, L*)
Thwing-Albert Instrument Co., Phila., Pa., (*J, L*)
Torsion Balance Co., Clifton, N. J. (*F*)
United States Testing Co., Inc., Hoboken, N. J. (*A, H, J, L*)
Wyzenbeek & Staff, Inc., Chicago (*A*)

TRAPS, STEAM

●Powers Regulator Co., Skokie, Ill.
●Sterling, Inc., Milwaukee, Wisc.

VACUUM EQUIPMENT, HIGH

(For Coating, Etc.)

Beach-Russ Co., New York
Central Scientific Company, Chicago
Consolidated Electrodynamics Corp., Rochester Division, Rochester, N.Y.
Dorrie Process Co., Inc., Brooklyn, N. Y.
●Hull-Standard Corp., Abington, Pa.
●Mercury Industries, Inc., Hillsdale, N. J.
●N. R. C. Equipment Corp., Newton, Mass.
●Portage Plastics Co., Portage, Wisc.
Societe De L'Electronique Francaise, Asnieres, France
Vacuum Metalizing Corp., L. I. C., New York

VACUUM PLATING HOLDING RACKS

●Conforming Matix Corp., Toledo, Ohio
●Finish Engineering Co., Inc., Erie, Pa.
●Hull-Standard Corp., Abington, Pa.
Seal Cast Co., Inc., Phila., Pa.

VIBRATORS

Stow Mfg., Co., Binghamton, N. Y.
Syntron Co., Homer City, Pa.

WEIGH-FEEDERS

Detecto Scales, Inc., Bklyn, N. Y.
Exact Weight Scales Co., Columbus, Ohio
Glengarry Equipment Corp., Bay Shore, New York
Machine Factory & Foundry Ltd., Netstal/Gl, Switzerland
New England Engineering & Mfg., Co., Worcester, Mass.
Syntron Co., Homer City, Pa.

WELDING, PLASTIC

●American Agile Corp., Maple Hts., Ohio
Argo Plastics Products, Cleveland, Ohio
●Cosmos Electronic Machine Co., New York
●D & R Plastic Welders, Inc., Hazardville, Conn.
Guild Electronics Inc., New York
Richter, Frederic A., Chicago
●Sealomatic Electronics Corp., Bklyn., N. Y.
Societe De L'Electronique Francaise, Asnieres, France
Weld Plastics, Inc., Newark, N. J.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149.

MACHINE TOOLS

For related editorial information see pp. 650, 818, 890.

CUTTING TOOLS

(Routers, Millers, Cutters, Etc.)

Crucible Steel Co. of America, Pittsburgh, Pa.
Deluxe Saw & Tool Co., Louisville, Ky.
• Gorton, George, Machine Co., Racine, Wisc.
• Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
• Mico Instrument Co., Cambridge, Mass.
• Plastic Molders Supply Co., Inc., Fanwood, N. J.
Pratt & Whitney Co., Inc., West Hartford, Conn.
Radical Cutter Manufacturing Corp., Elizabeth, N. J.
Sieburg Industries, Inc., Tensilkut Div., New Britain, Conn.

MACHINES, BORING

Boice-Crane Company, Toledo, Ohio
Pratt & Whitney Co., Inc., West Hartford, Conn.

MACHINES, BROACHING

Buttondex Corp., New York
• Cincinnati Milling Machine Co., Cincinnati, Ohio

MACHINES, DIE SINKING

• Cincinnati Milling Machine Co., Cincinnati, Ohio
• Elmes Engineering Div., American Steel Foundries, Cincinnati, Ohio
• Gorton, George, Machine Co., Racine, Wisc.
Pratt & Whitney Co., Inc., Hartford, Conn.
Preis, H. P., Engraving Machine Co., Hillside, N. J.
• Reed-Prentice Corp., Worcester, Mass.
Turchan Follower Mach., Co., Dearborn, Mich.
• Watson-Stillman Press Div. Farrel-Birmingham Company Inc., Roselle, N. J.

MACHINES, DRILLING

A. Drill Presses, Multiple Spindle
B. Drill Presses, Single Spindle
C. Jig Borers

Barker-Davis, Leominster, Mass. (*A, B*)
Boice-Crane Company, Toledo, Ohio (*A, B*)
Commander Mfg., Co., Chicago (*A*)
Electro-Mechano Co., Milwaukee, Wisc. (*A, B*)
Hamilton Tool Co., Hamilton, Ohio (*A, B*)
Ketchpel Engineering Co., West Englewood, N. J. (*A*)
• Mico Instrument Co., Cambridge, Mass. (*B*)
Pratt & Whitney Co., Inc., West Hartford, Conn. (*C*)
Sommer & Maca Glass Machinery Co. Chicago, Ill. (*A, B*)

MACHINES, DUPLICATING

• Gorton, George, Machine Co., Racine, Wisc.
Pratt & Whitney Co., Inc., West Hartford, Conn.
Preis, H. P., Engraving Machine Co., Hillside, N. J.
Sieburg Industries Inc., Tensilkut Div., New Britain, Conn.
Turchan Follower Mach., Co., Dearborn, Mich.

MACHINES, ENGRAVING

Lembo Machine Works, Inc., Paterson, N. J.
• Mico Instrument Co., Cambridge, Mass.
• New Hermes Engraving Machine Corp., N. Y.
Preis, H. P., Engraving Machine Co., Hillside, N. J.
Techcraft Co., Boston, Mass.
• Windsor, R. H., Ltd., Chessington, England

MACHINES, GRINDING

A. Grinders, Bench (Bench and Tap)
B. Grinders, Centerless
C. Grinders, Internal
D. Grinders, Portable Hand
E. Grinders, Surface
F. Grinders, Universal and Tool

Bellows Co., Akron, Ohio (*D*)
Carborundum Co., Niagara Falls, N. Y. (*A, B, C, D, E, F*)
• Cincinnati Milling Machine Co., Cincinnati, Ohio (*B, E, F*)
Fisher Scientific Company, Pitts., Pa. (*E*)
• Gorton, George Machine Co., Racine, Wis. (*F*)
Norton Company, Worcester, Mass. (*E, F*)
Pratt & Whitney Co., Inc., West Hartford, Conn. (*C, E, F*)
Royal Master, Inc., Riverdale, N. J. (*B*)
Van Norman Machine Co., Springfield, Mass. (*B, C, E*)
Wyzenbeek & Staff, Inc., Chicago (*D*)

MACHINES, KELLERING

Pratt & Whitney Co., Inc., West Hartford, Conn.

MACHINES, LATHES

(*Turning, Boring, Etc.*)

Boice-Crane Company, Toledo, Ohio
Ketchpel Engineering Co., West Englewood, N. J.
• Logan Engineering Co., Chicago
• Reed-Prentice Corp., Worcester, Mass.

MACHINES, MILLING

A. Plain Milling
B. Rotary Head Milling
C. Universal Milling
D. Vertical Milling

• Cincinnati Milling Machine Co., Cincinnati, Ohio (*A, C, D*)
• Gorton, George, Machine Co., Racine, Wisc. (*A, C, D*)
Ketchpel Engineering Co., West Englewood, N. J. (*A*)
• Reed-Prentice Corp., Worcester, Mass. (*C, D*)
Van Norman Machine Co., Springfield, Mass. (*A, B, C, D*)

MACHINES, PLANING AND SHAPING

Boice-Crane Company, Toledo, Ohio
Pratt & Whitney Co., Inc., West Hartford, Conn.

MACHINES, PROFILING

• Cincinnati Milling Machine Co., Cincinnati, Ohio
• Gorton, George, Machine Co., Racine, Wisc.
• Mico Instrument Co., Cambridge, Mass.
Pratt & Whitney Co., Inc., West Hartford, Conn.
Preis, H. P., Engraving Machine Co., Hillside, N. J.
Sieburg Industries, Inc., Tensilkut Div., New Britain, Conn.
Turchan Follower Mach., Co., Dearborn, Mich.

MACHINES, ROUTING

• Gorton, George, Machine Co., Racine, Wisc.
• Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
• Royle, John & Sons, Paterson, N. J.
Sieburg Industries, Inc., Tensilkut Div., New Britain, Conn.
• Standard Tool Co., Leominster, Mass.

• Indicates Advertiser.

SUPPLIES

For related editorial information see pp. 650, 818, 890.

ABRASIVE MATERIALS

- Acme Scientific Company, Chicago
- Carborundum Co., Niagara Falls, N. Y.
- Chemical Development Corp., Danvers, Mass.
- Composition Materials Co., Inc., New York
- Cratex Mfg. Company, San Francisco, Calif.
- Hewitt, C. B., & Bros, Inc., New York
- Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
- Lacrinoid Products Ltd., Essex, England
- Lea Manufacturing Co., Waterbury, Conn.
- Loed Chemical Corp., York, Pa.
- Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
- Minnesota Mining & Mfg. Co., St. Paul, Minn.
- Norton Company, Worcester, Mass.
- Raybestos-Manhattan, Inc., Passaic, N. J.
- Scientific Abrasives, Chicago
- Sirotta, Bernard, Co., Brooklyn, N. Y.
- Sommer and Maca Glass Machinery Co., Chicago
- Tumb-L-Matic, Inc., St. Mary's St., Stamford, Conn.
- Vapor Blast Mfg. Co., Milwaukee, Wisc.
- Wagner, Charles A. Co., Phila., Pa.

BAGS, MULTIWALL PAPER

- Bemis Bros. Bag Company, St. Louis, Mo.
- Continental Can Co., Inc., Shellmar-Vetner Div., Mt. Vernon, Ohio
- Equitable Paper Bag Co., Inc., Long Island City, N. Y.
- Milprint, Inc., Milwaukee, Wisc.
- Owens-Illinois Glass Company, Toledo, Ohio

BAGS, VACUUM AND PRESSURE

- Blossom Mfg., Co., New York
- Continental Can Co, Inc., Shellmar-Betner Div., Mt. Vernon, Ohio
- Milprint, Inc. Milwaukee, Wisc.
- Shore Line Industries, Clinton, Conn.

BELTS, BANDS AND SPECIALTIES, ABRASIVE

- Cratex Mfg., Company, San Francisco, Calif.
- Sommer & Maca Glass Machinery Co., Chicago

BELTS, STAINLESS STEEL

- Metalsmiths Div., Orange Roller Bearing Co., Orange, N. J.
- Sandvik Steel, Inc., Fair Lawn, N. J.

BERYLLIUM FOR MOLDS

(see *Material for Hobs and Molds*)

- Manco Products Inc., Melvindale, Mich.

BOXES, CORRUGATED AND SOLID FIBRE

- Consolidated Paper Co., Monroe, Mich.
- Cornell Paperboard Products Co., Milwaukee, Wisc.
- Federal Container Corp., Minneapolis, Minn.
- Gaylord Container Corp., St. Louis, Mo.
- Growers Container Corp., Salinas, Calif.
- Hinde & Dauch, Sandusky, Ohio
- Inland Container Corp., Indianapolis, Ind.
- Jodee Plastics Co., Brooklyn, N. Y.
- Mankato Paper Box Co., Mankato, Minn.
- National Vulcanized Fibre Co., Wilmington, Del.
- Oppenheimer Corp., Buffalo, New York
- Owens-Illinois Glass Company, Toledo, Ohio
- River Raisin Paper Co., Monroe, Mich.
- Wabash Fibre Box Co., Terre Haute, Ind.

BOXES, TOTE

- Aacon Industries, Inc., New York
- American Hard Rubber, New York
- Artmore Plastics Corp., Cumberland, Maryland
- Cadillac Plastic & Chemical Co., Detroit, Mich.
- Chemtron Fiber Glass Co., Elmonte, Calif.
- Clinwill Plastics, Inc., Buffalo, New York
- Continental-Diamond Fibre Corp., Newark, Del.
- Convoy, Incorporated, Canton, Ohio
- Dura Plastics of New York, New York
- Gaylord Container Corp., St. Louis, Mo.
- Hinde & Dauch, Sandusky, Ohio
- Hollywood Plastic Arts, Los Angeles, Calif.
- Lewis, G. B. & Co., Watertown, Wisc.
- National Vulcanized Fibre Co., Wilmington, Del.
- Somerset Industrial Designs, Inc., Somerville, N. J.
- Waterbury Companies, Inc., Waterbury, Conn.
- Westinghouse Electric Corp., Micarta Div., Hampton, S. C.
- Wilco Co., Los Angeles, Calif.

BUFFING AND POLISHING COMPOUNDS

- Cadillac Plastic & Chemical Co., Detroit, Mich.
- Composition Materials Co., Inc., New York
- Harrison & Company, Inc., Haverhill, Mass.
- Industrial & Domestic Silicone Distributor, Reseda, Calif.
- Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
- Lea Manufacturing Co., Waterbury, Conn.
- Loed Chemical Corp., York, Pa.
- Lupoline Automatic Polishing Equipment Corp., Tuckahoe, N. Y.
- Micron Specialties Co., Chicago
- Merix Chemical Company, Chicago
- Puritan Manufacturing Co., Waterbury, Conn.
- Scientific Abrasives, Chicago
- Sirotta, Bernard, Co., Brooklyn, N. Y.
- Wilco Co., Los Angeles, Calif.

CLAMPS

- Fisher Scientific Company, Pittsburgh, Pa.
- International Plastic, New York
- Murray Corp., Towson, Maryland
- Serwell Products Co., Cleveland, Ohio
- Tinnerman Products, Inc., Cleveland, Ohio

CUT-OFF WHEELS

- Carborundum Co., Niagara Falls, N. Y.
- Raybestos-Mahattan, Inc., Passaic, N. J.
- Scientific Abrasives, Chicago
- Sommer & Maca Glass Machinery Co., Chicago

DECALCOMANIA

- Aacon Industries, Inc., New York
- Criterion Decalcomania Co., Inc., New York
- Goodren Products Corp., Englewood, N. J.
- Midwest Decalcomania Co., Chicago
- Milprint, Inc., Milwaukee, Wisc.

DRUMS, SHIPPING

A. *Fibre*
B. *Metal*

- Consolidated Paper Co., Monroe, Mich. (*A*)
- Greif Bros., Cooperage Corp., Lindenhurst, N. Y. (*A, B*)

ELECTRODES, HIGH FREQUENCY HEAT SEALING

- Allied Engravers, Inc., New York
- Cosmos Electronic Machine Co., New York
- Guild Electronics Inc., New York
- Kabar Manufacturing Corp., New York
- Mayflower Electronic Devices, Inc., Littleferry, N. J.
- Plastic Welding Corp., Newark, N. J.
- Weld Edge Plastics, Inc., Newark, N. J.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

FASTENING DEVICES

(See also Screws)

Brush Nail Expansion Bolt Co., Greenwich, Conn.
Central Screw Company, Chicago
Hassall, John, Inc., Westbury, N. Y.
Palnut Company, Mountainside, N. J.
Paragon Plastic Corp., New York
Phelps Mfg., Co., Westport, Conn.
Tinnerman Products, Inc., Cleveland, Ohio

FLEXIBLE MATERIALS FOR MOLDS

Biggs, Carl H., Co., Inc., Los Angeles, Calif.
Chemical Development Corp., Danvers, Mass.
•Chemical Products Corp., E. Providence, R. I.
•General Tire & Rubber Co., Bolta Products Div., Lawrence, Mass.
Houghton Laboratories, Inc., Olean, N. Y.
Parcloid Chemical Co., Midland Park, N. J.
Ren Plastics Inc., Lansing, Mich.
•Reynolds Chemical Products Co., Ann Arbor, Mich.
Technicraft Co., Boston, Mass.
Tylene Plastics, Michigan City, Ind.

HINGES, SPECIALTY METAL

•Geissel Manufacturing Co., Inc., Hillside, N. J.

HOSE AND TUBING

(Flexible Metal)

Flexaust Company, New York
Orchard Industries, Inc., Hastings, Mich.
Packless Metal Hose, Inc., Mt. Vernon, N. Y.

INKS

(For Printing Plastics)

•Acromark Company, Elizabeth, N. J.
•Apex Machine Co., College Point, N. Y.
Bensing Bros., & Deeney, Phila., Pa.
California Ink Company, Inc., San Francisco, Calif.
•Chemical Products Corp., East Providence, R. I.
Entwistle Manufacturing Corp., Providence, R. I.
Garan Chemical Corp., Gardena, Calif.
International Marking Machine, New York
•Irwin, Jewell, & Vinson Co., Dayton, Ohio
Jamestown Finishes, Inc., Jamestown, N. Y.
Kellogg, M. W., Company, Jersey City, N. J.
•Krieger Color Chemical Co., Inc., Los Angeles, Calif.
•Logo, Inc., Chicago
Markem Machine Co., Keene, N. H.
Matthews, Jas. H., & Co., Pitts., Pa.
Palmer, Homer W., & Co., Chicago
•Schwartz Chemical Co., New York
•Stanley Chemical Co., East Berlin, Conn.
•Sun Chemical Corp., L. I. C., New York
Vansul Sales Co., Englewood, N. J.

INSERTS

Groov-Pin Corp., Ridgefield, N. J.
Industrial Engineering Service, South Easton, Mass.
Maplewood Companies, Livingston, N. J.
Paragon Plastic Corp., New York
Phelps Mfg., Co., Westport, Conn.

JOINTS

(Flexible-Ball, Pipe, Swivel, Revolving)

Barco Manufacturing Co., Barrington, Ill.
Chiksan Co., Brea, Calif.
Rotherm Engineering Co., Inc., Chicago
Stowe Mfg., Co., Binghamton, N. Y.

KNIVES

(For Granulators and Cutters)

• Taylor, Stiles & Co., Reigelsville, N. J.

LABELS, PRESSURE SENSITIVE

(Self-Adhesive, for Plastics)

Aacon Industries, Inc., New York
Allen Hollander Co., Inc., New York
Archer Label Co., Los Angeles, Calif.
Avery Adhesive Label Corp., Monrovia, Calif.
Ever Ready Label, Belleville, N. J.
Goodren Products Corp., Englewood, N. J.
• Hopp Plastics, New York
Labelon Tape Co., Inc., Rochester, N. Y.
Midwest Decalcomania Co., Chicago
Minnesota Mining & Mfg., Co., St. Paul, Minn.
Nas-Kay Industries, Phila., Pa.

LAMPS, INFRARED

(See also Drying Equipment)

Cleveland Process Co., Cleveland, Ohio
• Entoleter Division, Safety Industries Inc., New Haven, Conn.
• Fostoria Pressed Steel Corp., Fostoria, Ohio
North American Electric Lamp, St. Louis, Mo.

MASKING PAPER AND TAPE

Carborundum Co., Niagara Falls, N. Y.
Johns-Manville, New York
Minnesota Mining & Mfg., Co., St. Paul, Minn.
Permacel Tape Corp., New Brunswick, N. J.
Serwell Products Co., Cleveland, Ohio
Sorg Paper Company, Middletown, Ohio
Williamson Adhesives, Inc., Skokie, Ill.

MATERIAL HANDLING EQUIPMENT

(Except expendable)

Tote System, Inc., Beatrice, Neb.

MATERIALS FOR HOBS AND MOLDS

(Steel, Beryllium, Etc.)

Brush Beryllium Company, Cleveland, Ohio
•Cadillac Plastic & Chemical Co., Detroit, Mich.
Chemical Development Corp., Danvers, Mass.
Crucible Steel Co. of America, Pittsburgh, Pa.
Latrobe Steel Company, Latrobe, Pa.

MATERIALS, MOLD MAKING

•Bestwall Certain-teed Sales Corp. Ardmore, Pa.
Chemical Development Corp., Danvers, Mass.
Chemical Products Corp., East Prov., R. I.
Crucible Steel Co., of America, Pittsburgh, Pa.
Elastomer Chemical Corp., Newark, N. J.
Houghton Laboratories, Inc., Olean, N. Y.
•Newbury Industries, Inc., Newbury, Ohio
Plastic Enterprises, College Pt., N. Y.
Ren Plastics Inc., Lansing, Mich.
•Schwartz Chemical Co., Inc., New York
Scientific Abrasives, Chicago

MOLD CLEANING COMPOUNDS

Agrashell, Inc., Los Angeles, Calif.
Chemical Development Corp., Danvers, Mass.
Garan Chemical Corp., Gardena, Calif.
Merix Chemical Company, Chicago
Oakite Products, Inc., New York
Pennsylvania Refining Co., Cleveland, Ohio
Puritan Manufacturing Co., Waterbury, Conn.
Scientific Abrasives, Chicago
Sirotta, Bernard, Co., Brooklyn, N. Y.
•Synthetic Products Co., Cleveland, Ohio

MOLD RELEASE AGENTS

(Mold Lubricants)

•Advance Solvents & Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, N. J.
Aries Laboratories, Inc., Long Island City, N. Y.
B. B. Chemical Co., Cambridge, Mass.
Baker Castor Oil Co., Bayonne, N. J.
•Barrett, Div. Allied Chemical & Dye Corp., New York
Biggs, Carl H., Co., Inc., L. A., Calif.
•Borco Chemicals, Inc., Chicago
•Carbide & Chemicals Co., Div. of Union Carbide Corp., New York
Chemical Development Corp., Danvers, Mass.
Dennis Chemical Co., St. Louis, Mo.
Dow Corning Corp., Midland, Mich.
•Du Pont, E. I. deNemours, & Co., Inc., Wilmington, Del.
Eveready Pressurized Products, Inc., Cleveland, Ohio
Flexcraft Industries, Newark, N. J.
Garan Chemical Corp., Gardena, Calif.
Glyco Products Co., Inc., New York
• Harwick Standard Chemical Co., Akron, Ohio
Houghton, E. F. & Co., Phila., Pa.

•Indicates Advertiser.

Houghton Laboratories, Inc., Olean, N. Y.
Industrial & Domestic Silicone Distributor, Reseda, Calif.
• Injection Molders Supply Co., Cleveland, Ohio
Johnson, S. C. & Son, Inc., Racine, Wisc.
Lami-Plast Products Co., Tampa, Florida
• Lago, Inc., Chicago
Mallinckrodt Chemical Works, St. Louis, Mo.
Merix Chemical Company, Chicago
Minnesota Mining & Mfg. Co., St. Paul, Minn.
Moldrite Products Co., Providence, R. I.
• Naugatuck Chemical, Div. of U. S. Rubber, Naugatuck, Conn.
• Plastic Molders Supply Co., Inc., Fanwood, N. J.
Plastics Associates, Pasadena, Calif.
• Polyplastex United, Inc., Union, N. J.
Price Driscoll, New York
Ren Plastics Inc., Lansing, Mich.
Reynolds Metals, Co., Plastics Div., Grottoes, Va.
Rezolin, Inc., Santa Monica, Calif.
• Schwartz Chemical Co., Inc., New York
• Semet-Solvay Petrochemical Div., Allied Chem. & Dye Corp., New York
Serwell Products Co., Cleveland, Ohio
Specialty Products Co., Jersey, N. J.
• Stanley Chemical Co., East Berlin, Conn.
• Synthetic Products Co., Cleveland, Ohio
Technicraft Co., Boston, Mass.
• Thoreson-McCosh, Inc., Detroit, Mich.
Tylene Plastics, Inc., Michigan City, Ind.

OIL, HEAT TRANSFER AND HYDRAULIC

• Carbide & Chemicals Co., Div. of Union Carbide Corp., New York
• Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Houghton, E. F. & Co., Phila., Pa.
Pennsylvania Refining Co., Cleveland, Ohio
Union Oil Co. of California, Los Angeles, Calif.

PACKING, HYDRAULIC

Garlock Packing Company, Palmyra, N. Y.
Houghton, E. F. & Co., Phila., Pa.
Johns-Manvill, New York
• M & N Modern Hyraulic Press, Clifton, N. J.
Parker Appliance Company, Cleveland, Ohio
Raybestos-Mahattan, Inc., Passaic, N. J.

PARTICLE BOARD

Weyerhaeuser Sales Co., St. Paul, Minn.
Wynnewood Products Co., Jacksonville, Texas

PARTITIONS, PACKAGING

Artmor Plastics Corp., Cumberland, Maryland
Cornell Paperboard Products Co., Milwaukee, Wisc.
Federal Container Corp., Minneapolis, Minn.
Hinde & Dauch, Sandusky, Ohio
River Raisin Paper Co., Monroe, Mich.
Wabash Box Co., Terre Haute, Ind.

PIPE JOINT COMPOUNDS

American Hard Rubber, New York
Atlas Mineral Products Company, Mertztown, Pa.
• Chemical Products Corp., East Prov., R. I.
Dennis Chemical Co., St. Louis, Mo.
Garlock Packing Co., Palmyra, N. Y.
Haveg Industries, Inc., Wilmington, Del.
Lake Chemical Co., Chicago
Parker Appliance Company, Cleveland, Ohio
• Reynolds Chemical Products Co., Ann Arbor, Mich.

PURGING COMPOUNDS

Amco Plastic Materials, Inc., Brooklyn, N. Y.
• American Molding Powder & Chemical Corp., Brooklyn, N. Y.
• Gering Products, Inc., Kenilworth, N. J.
• Injection Molders Supply Co., Cleveland, Ohio
Merix Chemical Company, Chicago
Multiplastics-Inc., Wallingford, Conn.
• Plastic Molders Supply Co., Inc., Fanwood, N. J.
• Semet-Solvay Petrochemical Div., Allied Chem. & Dye Corp., New York
Scientific Abrasives, Chicago
Wasco Products, Inc., Cambridge, Mass.

RELEASE PAPERS

American Combining Corp., Rockaway Beach, Queens, N. Y.
• Endura Corp., Quakertown, Pa.
• Mosinee Paper Mills Co., Mosinee, Wis.
Newark Paraffine & Parchment, Newark, N. J.
Paterson Parchment Paper Company, Bristol, Pa.
• Riegel Paper Corp., New York
Sorg Paper Company, Middletown, Ohio

ROLL LEAF

(Stamping Foil)

• Acromark Company, Elizabeth, N. J.
Admiral Coated Prods., Inc., Bklyn., N. Y.
• Apex Machine Co., College Point, N. Y.
• Gane Bros., & Lane, Inc., Chicago
• General Roll Leaf Mfg. Co., Elmhurst, L. I., N. Y.
Gravert, R. W., Inc., New York
Griffin, Campbell, Hayes, Walsh, Inc., New York
• Kingsley Stamping Machine Co., Hollywood, Calif.
Metallizing Products Co., Norwalk, Conn.
• Olsenmark Corp., New York
• Peerless Roll Leaf Co., Inc., Union City, N. J.
Reichel Paper Corp., New York
Swift, M. & Sons, Inc., Hartford, Conn.

ROLLERS, FOR ROLLER COATING

• Apex Machine Co., College Point, N. Y.
• Cylinder Mfg., Co., Hawthorne, N. J.
• Finish Engineering Co., Inc., Erie Pa.
Inta-Roto Machine Co., Richmond, Va.
Lembo Machine Works, Inc., Paterson, N. J.
• Roehlen Engraving Works, Inc., Rochester, N. Y.
Stowe-Woodward, Inc., Newton Upper Falls, Mass.

SAW BLADES

Disston, Henry Division, H. K. Porter Company, Inc., Phila., Pa.
Do All Company, Des Plaines, Ill.
• Forrest Mfg. Co., Rutherford, N. J.
• Lemmon & Snop, Grand Rapids, Mich.
Radical Cutter Manufacturing Corp., Elizabeth, N. J.
Simonds Saw & Steel Co., Fitchburg, Mass.

SCREWS

(Drive, Thread Cutting, Thread Forming)

Central Screw Company, Chicago
Electro-Chemical Products Corp., Cleveland, Ohio
Hassall, John Inc., Westbury, N. Y.
• Johnson Manufacturing Co., Chippewa, Wisc.
Paragon Plastic Corp., New York
• Parker-Kalon Div., General American Transportation Corp., Clifton, N. J.
Southern Screw Company, Statesville, N. Carolina

SCREWS EXTRUDER

• Davis-Standard, Div. of Franklin Research, Mystic, Conn.
Fabbrica Prodotti Thermoplasitici Carlo Pasquetti, Varese, Italy
• Killion Tool Mfg., Co., Verona, N. J.

SPRAY PAINTING FIXTURES

Binks Manufacturing Company, Chicago
• DeVilbiss Company, Toledo, Ohio
• Finish Engineering Co., Inc., Erie, Pa.
Fiore, Wm. H., Bklyn., N. Y.
Houghton Laboratories, Inc., Olean, N. Y.
Pareagon Plastic Corp., New York
Serwell Products Co., Cleveland, Ohio
W & A Co., Inc., Attleboro, Mass.

TAPS

Bath, John & Company, Inc., Worcester, Mass.
Bay State Tap & Die Company, Mansfield, Mass.
Hypro Tool Company, New Bedford, Mass.

TOOLS, CARBIDE TIPPED

Allegheny Ludlum Steel Corp., Pittsburgh, Pa.
• Forrest Mfg., Co., Rutherford, N. J.
• Kramer, H. W., Co., Inc., Rich. Hill, N. Y.
Maplewood Companies, Livingston, N. J.

• Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

TUBES, H. F. ELECTRONIC

Guild Electronics Inc., New York

TUMBLING MEDIA

(Pegs and Compounds)

Carborundum Co., Niagara Falls, N. Y.
•Chemical Products Corp., East Prov., R. I.
Cratex Mfg. Company, San Francisco, Calif.
Harrison & Company, Inc., Haverhill, Mass.
•Kramer, H. W., Co., Inc., Richmond Hill, N. Y.
Lacrinoid Products Ltd., Essex, England
Lea Manufacturing Co., Waterbury, Conn.
Lead Chemical Corp., York, Pa.
Lignum Chemical Works, L.I.C., N. Y.
•Lupoline Automatic Polishing Equipment Corp., Tuckahoe N. Y.
Minnesota Mining & Mfg., Co., St. Paul, Minn.
Merix Chemical Company, Chicago
Oakite Products, Inc., New York
Puritan Manufacturing Co., Waterbury, Conn.
Scientific Abrasives, Chicago
Sirotta, Bernard, Co., Brooklyn, N. Y.
Tumble-Buff Laboratories, Inc., Jamaica, N. J.
•Tumb-L-Matic, Inc., St. Mary's St., Stamford, Conn.

TUNGSTEN

Bergen Wire Rope Co., Lodi, N. J.
•Sylvania Electric Products, Inc., Towanda, Pa.

VALVES

A. Diaphragm Control
B. Fittings, Hydraulic
C. Fittings, Pneumatic

Airmatic Valve, Inc., Cleveland, Ohio (*A*)
American Hard Rubber, New York (*A, B, C*)
Askania Regulator Co., Chicago (*A, B, C*)
•Blackhawk Molding Co., Inc., Addison, Ill. (*A*)
Bradley & Turton Ltd., Kidderminster, U. K. (*B*)
•Clifton Hyraulic Press Co., Clifton, N. J. (*B, C*)
•Dunning & Boschert Press Co., Inc., Syracuse, N. Y. (*B*)
Greer Industries, Inc., Jamaica N. Y. (*B*)
Hanna Engineering Works, Chicago (*B, C*)
Parker Appliance Company, Cleveland, Ohio (*B, C*)
•Powers Regulator Co., Skokie, Ill. (*A*)
•Taylor Instrument Co., Rochester 1, N. Y. (*A*)

WIPE-IN PAINTS

(Stick Form)

•D & R Plastic Welders Inc., Hazardville, Conn.
Lake Chemical Co., Chicago
Markal Co., Chicago

SPECIALIZED SERVICES

APPLIED DECORATIONS ON PLASTIC

A. Dyeing
B. Engraving
C. Etching
D. Flocking
E. Gold Leaf Stamping
F. Marking
G. Metal Inlaying
H. Silk Screening
I. Spraying

A & B Plastics, Seattle, Wash. (*A, B, F, G, H, I*)
Aacon Industries, Inc., Brooklyn, N. Y. (*A, B, C, D, E, F, G, H, I*)
Accurate Gold Stamping Co., Inc., New York (*E*)
•Ace Plastic Co., Jamaica, N. Y. (*E*)
Acme Laminating & Plastics Co., Detroit, Mich. (*E, H, I*)
Acme Plastic Products Co., Inc., Horsham, Pa. (*E, F*)
•Acme Scientific Co., Chicago, Ill.
•Acromark Co., Elizabeth, N. J. (*B, C, E, F*)
Admiral Plastics Corp., Brooklyn, N. Y. (*E, H*)
Allied Engravers, Inc., New York (*B, C*)
Allied Engraving & Stamping Co., Buffalo, N. Y. (*B, E, F*)
American Combining Corp., Queens, N. Y. (*A, E, H, I*)
Ameriplastic Co., Flint, Mich. (*B, E, F, H, I*)
Amston Plastic Engineering Co., Amston, Conn. (*B*)
Aquador Plastics, Inc., Brooklyn, N. Y. (*H*)
Art Decorating Co., North Bergen, N. J. (*B, E, F, H*)
Art Plastic Mfg. Co., Los Angeles, Calif. (*E, F, H*)
Artmor Plastics Corp., Cumberland, Maryland (*B*)
Atkins & Merrill, Inc., South Sudbury, Mass. (*A, B, F, H, I*)
Atlas Plastics, Inc., Little Ferry, N. J. (*E*)
Augusta Plastics, Inc., Bronx, N. Y. (*E, H*)
•Barron, J. E., Plastics, Inc., Cincinnati, Ohio (*B, E, F, H, I*)
Becwar Manufacturing Corp., Addison, Ill. (*E, F, G*)
Berkander, George F., Inc., Providence, R. I. (*E, I*)
Bernard Plastics Molding Corp., Long Island City, N. Y. (*E*)
•Blackhawk Molding Co., Inc., Addison, Ill. (*E*)
Blackwell Plastic Molding Co., Inc., Houston, Texas (*E*)
•Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass. (*H, I*)
•Boonton Molding Co., Boonton, N. J. (*E, F, H, I*)
Borkland Mfg. Co., Marion, Ind. (*E, H, I*)
Bricmar Manufacturing Corp., New York (*H, I*)
Bridgeport Molded Products, Inc., Fairfield, Conn. (*E, I*)
Brilhart Plastics Corp., Mineola, N. Y. (*F*)
Brook Molding Corp., Norwood, Mass. (*A, E, H, I*)
Bruce Molded Plastic Prod., Pittsburgh, Pa. (*E, F, H*)
•Byrd Plastics, Inc., Erie, Pa. (*E, H*)
•Cadillac Plastic & Chemical Co., Detroit, Mich. (*B, E, H*)
Calabro Plastics, Upper Darby, Pa. (*B, E, H*)
Campro Co., Canton, Ohio (*E, F, H, I*)
Capitol Plastics Co., Inc., Lansing, Mich. (*H, I*)
Carolina Plastics Co., Charlotte, N. C. (*B, E, F, H, I*)
Carpenter, L. E., & Co., Wharton, N. J. (*B*)
•Carroll, J. B., Co., Chicago (*C, E, F, H*)
Century Plastics Co., Fitchburg, Mass. (*E, I*)
Chaney Plastic Molding Co., Denver, Colorado (*E, F*)
Chatelain Plastics, Findlay, Ohio (*B, E*)
Chelsea Mills, Div. of Novelty BB-Co., New York (*H*)
Chicago Price Tag Mfg. Co., Chicago (*H*)
Church, C. F., Div. of American-Standard, Holyoke, Mass. (*E, I*)
Clear View Plastics Corp., Poplar Bluff, Miss. (*A, E, H, I*)
Clinwill Plastics, Buffalo, N. Y. (*E*)
Colorite Buttons, New York (*A, B*)
Colors Unlimited, Los Angeles, Calif. (*A*)
Colt's Plastics Co., Inc., Hartford, Conn. (*E, F, H, I*)
Colin-Friedman Co., Springfield, N. J. (*E, F, H*)
Commonwealth Plastics Corp., Leominster, Mass. (*I*)
•Como Plastics, Inc., Columbus, Ind. (*E, F, G, H, I*)

•Indicates Advertiser.

Conn-Craft Co., Waterbury, Conn. (*B, E*)
Conneaut Rubber & Plastics Co., Conneaut, Ohio (*C, E, F*)
● Connecticut Plastic Products Co., Inc., Waterbury, Conn. (*A, B, C, D, E, F, G, H*)
● Continental-Diamond Fibre Corp., Newark, Del. (*B, E*)
Continental Plastics, Oklahoma City, Okla. (*I*)
Cowan Boyden Corp., Providence, R. I. (*E, H, I*)
Crook, William A., Co., Inc., Watertown, Mass. (*B, E*)
Cruver Mfg. Co., Chicago (*E, H, I*)
Crystalx Corp., Lenni Mills, Pa. (*B,F,H*)
Curbell, Inc., Buffalo, N. Y. (*B, H, I*)
Curry Arts Molding Laminating Co., Scranton, Pa. (*E, H*)
● Danielson Manufacturing Co., Danielson, Conn. (*A*)
Darnell Manufacturing Co., Orange, Va. (*E*)
● Davies, Harry, Molding Co., Chicago (*E, F*)
Dayton Plastics, Inc., Dayton, Ohio (*B, H*)
Dec-Art Process Co., Inc., New York (*A, D, H, I*)
Denver Plastics, Inc., Golden, Col. (*E, H, I*)
Dornbusch & Co., Krefeld, Germany (*B*)
Dura Plastics of New York, New York (*B, H, I*)
● Emeloid Co., Inc., Hillside, N. J. (*D, E, F, H, I*)
Emerson Plastics Corp., Bronx, N. Y. (*H*)
Engineering Nylon Products, Inc., South Bend, Ind. (*A*)
Entwistle Manufacturing Corp., Providence, R. I. (*F*)
Evans-Zeier Plastic Co., Madison, Wisc. (*E*)
Eyelet Specialty Co., Waterbury, Conn. (*H, I*)
Fabri-Kal Corp., Kalamazoo, Mich. (*E, F, H, I*)
Farrington Texol Corp., Walpole, Mass. (*A*)
Fawn Plastics Co., Inc., Baltimore, Md. (*E, F, H, I*)
● Federal Tool Corp., Chicago, Ill. (*E, H*)
Felsenthal, G., & Sons, Chicago (*E, F, H, I*)
Fiberoid Doll Products Corp., Bronx, N. Y. (*I*)
Flexible Products Co., Marietta, Ga. (*H, I*)
Forbes Products Corp., Rochester, N. Y. (*E, H*)
Franklin Plastics, Inc., Franklin, Pa. (*E*)
Fried Novelties, Brooklyn, N. Y. (*E*)
Garray Plastics Co., Inc., Kearny, N. J. (*E, F*)
● General Plastics Corp., Marion, Ind. (*H, I*)
● General Tire & Rubber Co., Marion, Ind. (*H, I*)
Gits Molding Corp., Chicago (*B, E, F, G, H, I*)
Gladwin Plastics, Inc., Atlanta, Ga. (*B, E, H, I*)
Glass, Harry H., & Bros., New York (*B, F*)
Glasseloid Corp. of America, Clifton, N. J. (*H, I*)
● Glidden Co., Cleveland (*D, H, I*)
Gomar Manufacturing Co., Inc., Linden, N. J. (*A*)

● Indicates Advertiser.

Gotham Plastic Corp., Bronx, N. Y. (*A, E*)
Great Lakes Plastic Co., Buffalo, N. Y. (*B*)
Grant & Roth Plastics, Inc., Portland, Oregon (*E*)
Haas Corp., Memdon, Mich. (*E, I*)
Hake Manufacturing Co., Inc., Roanoke, Va. (*E*)
Har-E-Dan Engravers, Brooklyn, N. Y. (*B, E, F*)
Hathaway Kraemer, Ltd., Kitchener, Ontario, Canada (*B, E, F, H, I*)
Hero Mfg. Co., Inc., Middleboro, Mass. (*A, E*)
Homalite Co., The, Wilmington, Delaware (*F, H*)
Ideal Gold Stamping Co., New York (*E, F, H*)
● Ideal Plastics, Div. Ideal Toy Corp., Hollis, N. Y. (*E, I*)
Imperial Industries, Inc., Wayne, Michigan (*B, H, I*)
Industrial Sales Engineers, New York (*B, E, F, H, I*)
Insulating Fabricators of New England, Inc., Watertown, Mass. (*B, C, H*)
International Engraving Corp., Cedar Grove, N. J. (*B*)
International Marking Machine Company, New York (*F*)
International Plastic, New York (*A, B, D, H, I*)
Jersey Plastic & Die Casting Co., Irvington, N. J. (*E*)
Jodee Plastic Co., Brooklyn, N. Y. (*B, F, H*)
Jupiter Plastics, Inc., Pittsfield, Mass. (*E, H, I*)
Just Plastics, Inc., New York (*B, E, H*)
Kaye Plastics Corp., New Brunswick, N. J. (*E, F, I*)
Kerr, R. W. Plastic Co., Hastings, Nebraska (*B, E, F, H, I*)
Kerrco Products, Lincoln, Nebraska (*B, E, F, H, I*)
● Kingman, E. B., Co., Inc., Leominster, Mass. (*E, F, I*)
Klise Manufacturing Company, Grand Rapids, Mich. (*E, H*)
● Krieger Color & Chemical Co., Inc., Los Angeles (*A*)
Kuhlman Plastics Co., Inc., Kansas City, Mo. (*E, H, I*)
Kusan Incorporated, Nashville, Tenn. (*E, F, H, I*)
Laminated Sheet Products Corp., Norwood, Mass. (*A, B, E, F, H*)
Leathertone, Inc., Boston, Mass. (*D, H*)
● Lincoln Molded Plastics, Inc., Circleville, Ohio (*A, B, E, H, I*)
Linehan and Company, Dallas, Texas (*I*)
Long, Thomas J., Inc., Carle Place, New York (*B, F, H, I*)
Ludascher, William C., Eddington, Pa. (*E*)
Lurie Plastics, Inc., Colonial Heights, Va. (*E, I*)
MacDonald Manufacturing Company, New Baltimore, Mich. (*E, G, I*)
Majestic Creations, Inc., Woodside, N. Y. (*H, I*)
Mankato Paper Box Co., Mankato, Minn. (*H*)
Manhattan & Electronic Die Co., New York (*B*)
Marbek Inc., Brooklyn, N. Y. (*I*)
● Mimosa Corp. Cardinal Div., Evansville, Ind. (*A, B, C, D, E, H, I*)
● Morningstar, The Corporation, Cambridge, Mass. (*E, I*)
Motson, J. Frank Co., Flourtown, Penna. (*F, H, I*)
● Michigan Plastic Products, Inc., Grand Haven, Mich. (*E, H, I*)
Michigan Panelyte Molded Plastics, Inc., Dexter, Mich. (*E, F, I*)
● Mico Instrument, Cambridge, Mass. (*B*)
Midwest Decalcomania Co., Chicago (*D, H*)
Mitchell Plastics, Inc., Owosso, Mich. (*E, G, H, I*)
Modern Molders, Kenilworth, N. J. (*E*)
Modern Plastic Co., Los Angeles (*E, I*)
● Molded Products, Division of Admiral Corp., West Chicago (*A, B, E, F, I*)
Monoplastics, Inc., Georgetown, Conn. (*B, C, E, F, H, I*)
● Morningstar Corp., Cambridge, Mass. (*E, I*)
Name Plate Products Co., Philadelphia, Pa. (*B, C, E, F, H, I*)
Nas-Kay Industries, Philadelphia, Pa. (*B, H*)
National Vacuum Platers, Inc., Philadelphia, Pa. (*I*)
● New Hermes Engraving Machine Corp., New York (*B*)
Newcraft Mfg. Corp., Long Island City, N. Y. (*E, F, H, I*)
Niagara Plastics Co., Inc., Erie, Penna. (*E, F, I*)
Nichols Products Co., Inc., Moorestown, N. J. (*E, G*)
Niles Corporation, South Bend, Indiana (*E, H*)
Norco Plastic Inc., Milwaukee, Wisc. (*B, D, E, H, I*)
Pacific Plasti-Fab Corp., San Carlos, Calif. (*B, H, I*)
Paragon Plastic Corporation, New York (*A, B, E, F, H, I*)
Pathway Plastic Corp., Mt. Vernon, N. Y. (*A, G*)
Pearless Mfg. & Distributing Company, Inc., Waukesha, Wisc. (*E, H, I*)
Perfex Plastics, Inc., Chicago (*E, I*)
Perma Seal Plastic Products Co., St. Paul, Minn. (*E*)
Permanent Label Corp., Bloomfield, N. J. (*E, F, H, I*)
Perry Plastics, Inc., Erie, Pa. (*E,F,H,I*)
Pioneer Valley Plastics Co., Chicopee, Mass. (*E, F, H*)
Plast-Ad Mfg. Co., South Bend, Indiana (*A, B, F, H, I*)
Plasti-Chemical Corp., Miami, Fla. (*E*)
Plastic Center, Rochester, N. Y. (*B*)
Plastic Embedments Co., Inc., Attleboro, Mass. (*B, D, E, H*)
Plastic Fabricators, New York (*B*)
Plastic Inlays Corp., Summit, N. J. (*A, D, E, F, G, H, I*)
Plastic Innovations, Inc., Yonkers, N. Y. (*B, H*)
Plastic Masters, Inc., New Buffalo, Mich. (*A, E, I*)
Plastic Suppliers & Manufacturers, Baton Rouge, La. (*B*)
Plastic Toys Corporation, Byesville, Ohio (*H, I*)
Plasticraft Manufacturing Co., Kearny, N. J. (*E, F, H, I*)
Plasticrafts, Inc., Denver, Colorado (*B, E, H*)
Plastics Center of Texas, San Antonio, Texas (*B, E, F, I*)
Plastics, Inc., St. Paul, Minn. (*B,E,F,H*)
Plastics, Laminates & Fabrics, Inc., Chicago (*B, D, E, F, H, I*)
● Plaxall, Inc., Long Island City, N. Y. (*D, E, H, I*)
● Plymouth Fibres, Inc., Brooklyn (*D*)
● Polymer Corp., The, Reading, Pa. (*A*)

Complete addresses of companies listed appear on pp. 1123-1149

Polymold Plastics, Inc., Chicago (*A, B, E, F, H, I*)
•Polyplastex United, Inc., Union, N. J. (*H, I*)
•Polyonco, Inc., Reading, Pa. (*A*)
Premier Plastics Co., Milwaukee, Wisc. (*B, C, E, F, G, H, I*)
Premier Plastic Mfg. Co., Minneapolis, Minn. (*B, E, H, I*)
Presco Plastics, Milwaukee, Wisc. (*A, E, I*)
Printloid Plastics, Inc., New York (*B, E, H, I*)
Product Engineering & Development Co., Hopkins, Minn. (*E*)
Pyramid Industrial Finishing Co., New York (*I*)
Randolph Products Co., Carlstadt, N. J. (*A, H*)
•Rayon Processing Co., The, of R. I., Pawtucket, R. I. (*D*)
Reinhardt, J. A. & Co., Mountainhome, Pa. (*B, H*)
Reinhardt Plastics Company, Denver, Colorado (*A, D, E, I*)
Reynolds Plastics, Inc., Walled Lake, Mich. (*B, E*)
•Ringler-Dorin, Inc., New York (*B*)
•Rogan Bros., Skokie, Ill. (*B, E, F*)
Romar Plastics, Inc., St. Charles, Ill. (*E, G*)
Royal Mfg. Co., Inc., Prescott, Arizona (*E, H*)
•Santay Corporation, Chicago (*E, F, H, I*)
Schaake, A. J. Co., St. Paul, Minn. (*B*)
Sealy Plastics Corp., Rockville, Conn. (*E, F*)
Shoe Form Co., Inc., Auburn, N. Y. (*E, F, I*)
•Sierra Electric Corp., Gardena, Calif. (*B*)
•Sillcocks-Miller Co., The, Maplewood, N. J. (*H*)
•Sinko, Mfg. & Tool Co., Chicago (*E, F, G, H, I*)
South Salem Studios, South Salem, N. Y. (*B, H, I*)
Southeastern Plastics, Inc., Portsmouth, Va. (*B, E, I*)
Southeastern Sales Corp., St. Petersburg, Fla. (*B, D, H, I*)
Southern Plastic Products Co., Riviera Beach, Fla. (*H, I*)
Specialties Imprinting Co., Cleveland, Ohio (*E*)
Sperzel Company, Minneapolis, Minn. (*E, F*)
Springfield Fabricators, Inc., Springfield, N. J. (*E, H*)
Star Mfg. Co., Little Ferry, N. J. (*B*)
Stensgaard, W. L. and Associates, Inc., Chicago (*D, H, I*)
Stimsonite, Div. Elastic-Stop Nut Corp. of America, Chicago (*H*)
Stricker, Carl, Bloomfield, N. J. (*B*)
Sun Plastics, Inc., Cuyahoga Falls, Ohio (*A, E, I*)
•Superior Plastics, Inc., Chicago (*E, F, H, I*)
Swenson, V. H. Co., Inc., Arlington, N. J. (*B, E, F, I*)
Syracuse Plastic Molders, Syracuse, N. Y. (*E, F, G, H, I*)
•Sylvania Electric Products, Inc., Warren, Pa. (*G, H, I*)
Technicraft Co., Boston, Mass. (*B*)
Thermold Corporation, Manlius, N. Y. (*D, E, H, I*)
Timely Products Mfg. Co., Des Moines, Iowa (*B, D, E, F, H, I*)
Transplastics Fabricating Co., Boston, Mass. (*B, E, H*)

•Indicates Advertiser.

Tri-State Plastic Molding Company, Henderson, Ky. (*E, H, I*)
Tulsa Plastics, Tulsa, Okla. (*B, E, H*)
Tumble-Buff Laboratories, Inc., Jamaica, N. Y. (*E*)
•20th. Century Plastics Co., Chicago (*E, F, G, H, I*)
United Mask & Nov. Co., Inc., Glendale, N. Y. (*H*)
U.S. Plastic Molding Corp., Wallingford, Conn. (*E*)
Vac-Art, Incorporated, Bay City, Mich. (*E, F, H, I*)
•Vacuum Plastics Corporation, Columbus, Ohio (*H*)
Vavrik-Industrial Design, Louis, Rossford, Ohio (*H*)
Vogel Mfg. Company, The, Bridgeport, Conn. (*E, F*)
W & A Co., Inc., Attleboro, Mass. (*A, B, C, E, F, I*)
Wachter Plastic Co., Sacramento, Calif. (*B*)
Waltco Products, Inc., Chicago (*H*)
Washington Plastic Co., Sharon, Pa. (*A, I*)
•Waterbury Companies, Inc., Waterbury, Conn. (*E, F, I*)
Welch Plastics & Mfg. Co., Inc., Columbus, Ohio (*E, F, G, H, I*)
Weld Edge Plastics, Inc., Newark, N. J. (*F*)
Westlake Plastics Company, Lenni Mills, Pa. (*B, F*)
Westmoreland Plastics Co., Inc., Latrobe, Pa. (*F, G, I*)
Willson Camera Co., Inc., Havertown, Pa. (*H*)
Zenith Plastics Co., Ypsilanti, Mich. (*B*)

ABRASIVE FORMING

•Ace Plastic Co., Jamaica, N. Y.
Industrial Plastic Supply Div., W. Hartford, Conn.
•Keolyn Plastics, Inc., Chicago
•Orange Products, Inc., Orange, N. J.
Plax Corp., Hartford, Conn.
Premier Plastics Co., Milwaukee, Wisc.
Scientific Abrasives, Chicago
Tumble-Buff Laboratories, Inc., Jamaica, N. Y.

BLOW MOLDING

Continental Can Co., Millsplastic Div., Chicago
Imco Container Corp., Kansas City, Mo.
Plax Corp., Hartford, Conn.
•Precision Extruders, Leominster, Mass.
Royal Plastics Co., Prescott, Arizona
Wheaton, T. C. Co., Mays Landing, N. J.

CASTING

A & B Plastics, Seattle, Wash.
Aacon Industries, Inc., Brooklyn, N. Y.
•American Agile Corp., Maple Hts., Ohio
Aries Laboratories, Inc., Long Island, N. Y.
Atkins & Merrill, Inc., South Sudbury, Mass.
Atlas Plastics, Inc., Buffalo, N. Y.
Bacon & Weber, Chicago
Bar-Design Associates, Irvington, N. J.
•Boonton Molding Co., Boonton, N. J.
•Cadillac Plastic & Chemical Co., Detroit, Mich.
Calabro Plastics, Upper Darby, Pa.
Capitol Plastics Co., Inc., Lansing, Mich.
•Cast Optics Corp., Hackensack, N. J.
Chemical Development Corp., Danvers, Mass.
Chemtron Fiber Glass Co., El Monte, Calif.
Clearfloat, Inc., Attle, Mass.
Conneaut Rubber & Plastics Co., Conneaut, Ohio
•Danielson Manufacturing Co., Danielson, Conn.
Emerson & Cuming, Inc., Canton, Mass.
Engineering Nylon Products, Inc., South Bend, Ind.
Everlite Corp., Seattle, Wash.
Fawn Plastics Co., Inc., Baltimore, Md.
Fiberoid Doll Products Corp., Bronx, N. Y.
Foam King, Inc., Bronx, N. Y.
Greer Industries, Inc., Jamaica, N.Y.
Hes Electrical Manufacturing Corp., El Monte, Calif.
Industrial Sales Engineers, New York
International Plastic, New York
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Libo Plastics Co., Milwaukee, Wisc.
Manco Products, Inc., Melvindale, Mich.
•Microcell, Ltd., Low Dow, England
Multiplastics, Div. of Curd Enterprises, Addison, Ill.
Niles Corporation, South Bend, Indiana
Omaha Plastics Co., Omaha, Nebraska
Paragon Plastic Corporation, New York
Plastic Embedments Co., Inc., Attleboro, Mass.
Plast-Ad Mfg. Co., South Bend, Ind.
Plasticrafts, Inc., Denver, Colorado
Plastic Pigment Co., Inc., Long Island City, N. Y.
Precision Coating Co., Inc., Needham, Mass.
Production Aid, Inc., Middletown, Ky.
Reinhardt Plastics Company, Denver, Colorado
Ren Plastics, Inc., Lansing, Mich.
Reynolds Plastics, Inc., Walled Lake, Mich.
Sarcol Foundry & Pattern Corp., Chicago
Skeist Laboratories, Newark, N. J.
South Salem Studios, South Salem, N. Y.
Springfield Cast Products, Inc., Springfield, Mass.
Starlite Plastic Co., Kenmore, N. Y.
Technicraft Co., Boston, Mass.
Wasco Products, Inc., Cambridge, Mass.
Washington Plastics, Inc., Sharon, Pa.

CONSULTANTS

A & B Plastics, Seattle, Wash.
Achille G. Bureau, New York
Acme Plastic Products Co., Inc., Horsham, Pa.
Airconductors, Compton, Calif.
•Akron Preform Mold Co., Coyahoga Falls, Ohio
Al-Be Industries, Bell Garden, Calif.
Amco Plastic Materials, Inc., Brooklyn, N. Y.
•American Agile Corp., Maple Hts., Ohio
American Molded Fiberglass Co., Paterson, N. J.
•Anorgano, G. M. B. H., New York
Applied Engineering Associates, Brooklyn, N. Y.
Applied Plastics Co., Inc., El Segundo, Calif.
Aquador Plastics, Inc., Brooklyn, N. Y.
Aries, R. S. & Associates, New York
Arnkurt Associates Engineers, New York
Art Plastic Mfg. Co., Los Angeles, N. J.
Artmor Plastics Corp., Cumberland, Maryland

Atkins & Merrill, Inc., South Sudbury, Mass.
Baco Co., New York
Bahlke, Alfred F., Berkeley Hts., N. J.
Bauer, George, Keene, N. H.
Becker & Becker Associates, New York
Ber-Design Associates, Irvington, N. J.
Bernard Plastics Molding Corp., Long Island City, N. Y.
● **Blackhawk Molding Co., Inc.,** Addison, Ill.
Blaw-Knox Co., Chemical Plants Div., Pittsburgh, Pa.
Blumenthal, Margaret M., New York
Bonwitt, Dr., G. L., Labs., New York
Bricmar Manufacturing Corp., New York
Bruce Molded Plastic Prod., Pittsburgh, Pa.
Bullock-Smith Associates, New York
C. T. L., Inc., Cincinnati, Ohio
● **Cadillac Plastic & Chemical Co.,** Detroit, Mich.
Campro Co., Canton, Ohio
Cantor, Robert Floyd, New York
Carmagnola, Ernest D., Jackson Hts., N. Y.
Chance, W. R., & Associates, Inc., Waldorf, Maryland
Chaney Plastic Molding Co., Denver, Colorado
Chemical Research, Upper Darby, Pa.
Chemical Development Corp., Danvers, Mass.
Chemold Co., Santa Monica, Calif.
Chemtron Fiber Glass Co., El Monte, Calif.
Cherry, Peter, Monroe, Conn.
Classic Studio, New York
Colburn Laboratories, Inc., Chicago
Colorite Buttons, New York
Colvin-Friedman Co., Springfield, N. J.
● **Como Plastics, Inc.,** Columbus, Ind.
Conneaut Rubber & Plastics Co., Conneaut, Ohio
Crest Chemical Industries Corp., Brooklyn, N. Y.
Crystalx Corp., Lenni Mills, Pa.
Custom Coatings Co., Los Angeles, Calif.
● **Danielson Manufacturing Co.,** Danielson, Conn.
Darr, Harold W., Associates, Minneapolis, Minn.
● **DeBell & Richardson, Inc.,** Hazardville, Conn.
● **Desert Sunshine Exposure Tests,** Phoenix, Arizona
● **Doven Machine & Eng., Inc.,** Chicago
Doxam Products, Inc., Middlesex, N. J.
Dura Plastics of New York, New York
Durra, J. B. & Co., Chicago
Electro Plastic Fabrics, Puldski, Va.
● **Egan, Frank W., & Co.,** Somerville, N. J.
Everlite Corp., Seattle, Wash.
Fabri-Kal Corp., Kalamazoo, Mich.
● **Fabrico Mfg. Corp.,** Chicago
Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio
● **Fine Organics, Inc.,** New York
Fischer, Andrew, Associates, Chicago
Florian, Gordon, Bridgeport, Conn.
Fukal, Alfred F., Houston, Texas
Gershom, Irvin J., Industrial Design, Maplewood, N. J.
Graf, John C., Co., Phila., Pa.
Greene, Ray, & Co., Toledo, Ohio
Guild Electronics, Inc., New York
● **H. & R. Industries,** Nazareth, Pa.
Hanley Plastics Co., St. Louis, Missouri
Hart, William, & Associates, St. Charles, Ill.
Hes Electrical Manufacturing Corp., El Monte, Calif.
Hollywood Plastic Arts, Los Angeles
Industrial Sales Engineers, New York
Jodee Plastic Co., Brooklyn, N. Y.
Jupiter Plastics, Inc. Pittsfield, Mass.
Kaye Plastics Corporation, New Brunswick, N. J.
Keck, Henry Associates, Pasadena, Calif.
Keystone Plastic Eng. Co., Chicago
King Designers, Detroit, Mich.
Kopplin Molding Corp., St. Louis, Mo.
Lami-Plast Products Co., Tampa, Fla.
Levin, Monte L., New York
● **Liberty Cutting Die Co.,** New York
Lithgow Chemicals Co. Division of Reinhold Engineering & Plastics Co. Norwalk, Calif.
● **Luminous Resins, Inc.** Chicago
Manco Products Inc., Melvindale, Mich.
Manhattan & Electronic Die Co., New York
Maplewood Companies, Livingston, N. J.
McCutcheon, George H., Los Angeles
Mechtronics, Philadelphia, Pa.
Metalmold Forming Co., New York
Murdoch, Colin D. San Leandro, Calif.
● **Microcell, Ltd.,** Low Dow, England
Mitchell Plastics, Inc. Owosso, Mich.
Modern Molders, Inc. Kenilworth, N. J.
Naken, William, Los Angeles
National Plastics, Inc. Knoxville, Tenn.
Navarm Chemical Co., Maywood, Calif.
● **Newark Die Company,** Newark, N. J.
New England Laboratories, Ipswich, Mass.
Norton, Arthur J. Consulting Chemist, Vachon, Washington
Oak Engineering Co. Inc. Gloucester City, N. J.
Peerless Mfg. & Distributing Company, Inc. Waukesha, Wisc.
Paragon Plastic Corporation, New York
Pacific Plastics Co. Inc. Seattle, Washington
Pioneer Plastics, Dayton, Ohio
Plasti-Chemical Corp., Miami, Fla.
Plastic Consultant Service, New York
Plastic Development Service, Pasadena, Calif.
Plastic Engineering Co., Pawtucket, R. I.
● **Plasticrafters, Inc.** Chicago
Plastic Suppliers & Manufacturing, Baton Rouge, La.
Plastic Welding Corp., Newark, N. J.
Poliner, William W., Englewood, N. J.
Polymold Plastics, Inc. Chicago
Precision Coating Co., Inc., Needham, Mass.
Presco Plastics, Milwaukee, Wisc.
Pribble Plastics Products, Inc., New Haven, Ind.
Protective Lining Corp., Brooklyn, N. Y.
● **Pyro Plastics Corporation,** Union, N. J.
Radiation Applications Incorporated, New York
Regal Plastic Co., Kansas City, Mo.
Reinhardt Plastics Company, Denver, Colorado
Resin Research-Laboratories, Inc., Newark, N. J.
Reynolds Plastics, Inc. Walled Lake, Mich.
Rhodes, Philip H. & Associates, Cincinnati, Ohio
● **Robbins Plastic Machinery Corp.,** Elkhart, Ind.
Rosenthal, Alfred A., New York
Rothenstein, Guy G. S. P. E. Forest Hills, N. Y.
Sajar Plastics, Inc., Middlefield, Ohio
Schaele, Edwin H. Ind. Design, Woodside N. Y.
Sealy Plastics, Corp., Rockville, Conn.
Singer, Lawrence H. Designer, New York
Singer, Lawrence H., Industrial Design, Jericho, N. Y.
Singleton, & Mack, Inc., Marietta, Ohio
Snell, Foster D, Inc., New York
Skeist Laboratories, Newark, N. J.
● **South Florida Test Service,** Miami, Fla.
Southwestern Plastics, Inc. Portsmouth, Va.
● **Southern Plastics Co.,** Columbin, S. C.
Sperzel Company, Minneapolis, Minn.
Springfield Cast Products, Inc. Springfield, Mass.
Springfield Fabricators, Inc. Springfield, N. J.
● **Standard Tool Co.,** Leominster, Mass.
Stewart, F. Associates, Los Angeles
Stricker, Carl, Bloomfield, N. J.
Stringfield, Raymond B., Los Angeles
● **Superior Plastics, Inc.** Chicago
Thal, Bernard, Boston, Mass.
Thombert, Inc. Newton, Iowa
United Sales Service, Los Angeles
United States Testing Co., Hoboken, N. J.
Vitro Engineering Division, Vitro Corporation of America, Washington, D. C.
Wessel, Stanley & Company, Chicago
Westlake Plastics Company, Lenni Mills, Pa.
Westmoreland Plastics Co. Inc. Latrobe, Pa.
Wills, John A. & Co., Pasadena, Calif.
● **Zapf, Charles, & Co.,** Evanston, Ill.
Zenner, Justin, Chicago

DESIGN PLATING ON PLASTICS

Aacon Industries, Inc., Brooklyn, N. Y.
Electrochemical Inds., Worcester, Mass.
● **G. M. C. Process Corp.,** New York
Mitchell Plastics, Inc., Owosso, Mich.
Plastic Inlays Corp., Summit, N. J.
Premier Vacuum Process Corp., Maspeth, N. Y.
● **Santay Corporation,** Chicago

DESIGNERS, INDUSTRIAL

A & B Plastics, Seattle, Wash.
Achille G. Bureau, New York
Acme Plastic Products Co., Inc., Horsham, Pa.
Airconductors, Compton, Calif.
● **Akron Presform Mold Co.,** Cuyahoga Falls, Ohio
Applied Engineering Associates, Brooklyn, N. Y.
Arnkurt Associates Engineers, New York
Art Plastics Mfg. Co., Los Angeles, Calif.
Atkins & Merrill, Inc., Southbury, Mass.
Ayres, Samuel, Jr., Ass't., Boston, Mass.
Baco Co., New York
Bacon & Weber, Chicago
Bahlke, Alfred F., Berkeley Hts., N. J.
Becker & Becker Associates, New York
Ber-Design Associates, Irvington, N. J.
Bernard Plastics Molding Corp., Long Island City, N. Y.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

Berni, Alan & Associates, Inc., New York
•Blackhawk Molding Co., Inc., Addison, Ill.
Blumenthal, Margaret M., New York
Brilhart Plastics Corp., Mineola, N. Y.
Bruce Molded Plastic Prod., Pittsburgh, Pa.
Budd, John, Eastford, Conn.
Burlington Molding Corp., Burlington, N. C.
Calabro Plastics, Upper Darby, Pa.
Cantor, Robert Floyd, New York
Carmagnola, Ernest D., Jackson Hts., N. Y.
Chemtron Fiber Glass Co., El Monte, Calif.
Cherry, Peter, Monroe, Conn.
Colburn Laboratories, Inc., Chicago
•Como Plastics, Inc., Columbus, Ind.
Dovey, Laird, Industrial Design, Monroe, Conn.
Darr, Harold W., Associates, Minneapolis, Minn.
Davies, Helen, & Associates, New York
Dayton Plastics, Inc., Dayton, Ohio
•DeBell & Richardson, Inc., Hazardville, Conn.
Design Dynamics, Inc., Chicago
Design Research, Inc., Chicago
Deskey, Donald, Associates, New York
•Deven Machine & Eng., Inc., Chicago
Ellies, Dave, Associates, Columbus, Ohio
Emstehrman, New York
•Fabrico Mfg. Corp., Chicago
•Falge Engineering Corp., Bethesda, Md.
Federico, Joseph B., Buffalo, N. Y.
Florian, Gordon, Bridgeport, Conn.
Frances Cushing Hall, Charlotte, N. C.
Fukal, Alfred F., Houston, Texas
Gary Enterprises, Inc., Brooklyn, N. Y.
Gershen, Irvin J., Maplewood, N. J.
Goldman, Neal, Associates, Inc., New York
Gore, Fred M., Industrial Design, Dallas, Texas
Goulding Mfg. Co., Saginaw, Mich.
Grover, Frederic S., Associates, Rochester, N. Y.
Gruen, Robert, New York
•H. M. S. Associates, Willow Grove, Pa.
Hanley Plastics Co., St. Louis, Mo.
Hart, William A., & Associates, St. Charles, Ill.
Hauser, Jon W., Inc., St. Charles, Ill.
Haveg Industries, Inc., Wilmington, Delaware
Herblin, The, Corp., Glen Cove, N. Y.
Howell, James A. & Marie, Designers, Providence, R. I.
Hughes, Henry, Belmont, Calif.
Huxtable, L. Garth, A.S.I.D., New York
Industrial Devices, Inc., Edgewater, N. J.
Industrial Eng. Service, South Easton, Mass.
International Plastic, New York
Keck, Henry, Associates, Pasadena, Calif.
Kerr, R. W. Plastic Co., Hastings, Nebraska
King, Designers, Detroit, Mich.
Kogan, Bello, Associates, New York
Levin, Monte L., New York
Lindsay, John, Denver, Colo.
Lippincott & Margulies, Inc., New York
Lustra-Cite Industries, Inc., Brooklyn, N. Y.
M. C. I. Plastic Corp., Lakewood, N. J.
Maplewood Companies, Livingston, N. J.
Maryland Plastics, Inc., Federalsburg, Md.
McCutcheon, George H., Los Angeles
•Microcell, Ltd., Low Dow, England
Mitchell Plastics, Inc., Owosso, Mich.
Multiplastics, Div. of Curd Enterprises, Addison, Ill.
Murdoch, Colin D., San Leandro, Calif.
Naken, William, Los Angeles
Nettleton, W. O. and Associates, Guilford, Conn.
Norco Plastic, Inc., Milwaukee, Wisc.
O'Connell, D. C., Associates, New York City
Paragon Plastic Corporation, New York
Pacific Plastics Co., Inc., Seattle, Washington
•Plasticrafters, Inc., Chicago
Plastic Suppliers & Manufacturers, Baton Rouge, La.
Plastic Model Engineering Co., Van Nuys, Calif.
Poliner, William, W. Englewood, N. J.
Preble, Harry, Jr., Cross River, N. Y.
Regal Plastic Co., Kansas City, Mo.
Reinecke & Associates, Chicago
Reinhold-Geiger Plastics, Inc., Los Angeles
Roger's Product Design, Leominster, Mass.
Rosenthal, Alfred A., New York
Rothenstein, Guy, Forest Hills, N. Y.
Sajar Plastics, Inc., Middlefield, Ohio
Sarcol Foundry & Pattern Corp., Chicago
Scheele, Edwin H., Ind. Design, Woodside, N. Y.
Singer, Lawrence H., Designer, New York
Singer, Lawrence H., Jericho, N. Y.
Sperzel Co., Minneapolis, Minn.
Stahl, Gerald, New York
Thal, Bernard, Boston, Mass.
Timely Products Mfg. Co., Des Moines, Iowa
Van Doren, Harold, Philadelphia, Pa.
Vavrik-Industrial Design, Louis, Rossford, Ohio
Westmoreland Plastics Co., Inc., Latrobe, Pa.
•Zapf, Charles, & Co., Evanston, Ill.

DIE CUTTING, PLASTIC SHEET STOCK

A & B Plastics, Seattle, Wash.
Aacon Industries, Inc., Brooklyn, N. Y.
Accurate Steel Rule Die Mfgs., New York
Acme Laminating & Plastics Co., Detroit, Mich.
Allied Engraving & Stamping Co., Buffalo, N. Y.
Alvimar Mfg. Co., New York
•American Agile Corp., Maple Hts., Ohio
•Anorgano, G.M.B.H., New York
Argo Plastic Products, Cleveland, Ohio
Art Plastics Mfg. Co., Los Angeles, Calif.
Atlas Plastic Specialties, Inc., Chicago
•Barron, J. E., Plastics, Inc., Cincinnati, Ohio
•Cadillac Plastic & Chemical Co., Detroit, Mich.
Calabro Plastics, Upper Darby, Pa.
Capitol Plastics Co., Inc., Lansing, Mich.
•Carroll, J. B., & Co., Chicago
Clinwill Plastics, Inc., Buffalo, N. Y.
Colvin-Friedman Co., Springfield, N. J.
Consolidated Plastic & Mfg. Co., Chicago
•Contour Extrusion Co., Mamaroneck, N. Y.
Cox Plastics Corp., Buffalo, N. Y.
Crook, William A., Co., Inc., Watertown, Mass.
Crystalx Corp., Lenni Mills, Pa.
Curry Arts Molding & Laminating Co., Scranton, Pa.
Denver Plastics, Inc., Golden, Col.
Dewes-Gumbs Die Co., Inc., New York
Duke Plastics Corp., Brooklyn, N. Y.
•Emeloid Co., Inc., Hillside, N. J.
Emerson Plastics Corp., Bronx, N. Y.
Engineered Plastics, Inc., Gibsonville, N. C.
Fabri-Form Co., Byesville, Ohio
Fabri-Kal Corp., Kalamazoo, Mich.
Forbes Products Corp., Rochester, N. Y.
G & R Manufacturing Co., New Britain, Conn.
Garlock Packing Co., Palmyra,
•General Plastics Corp., Marion, Ind.
Gladwin Plastics, Inc., Atlanta, Ga.
•Hopp Plastics, New York
Industrial Sales Engineers, New York
Insulating Fabricators of New England, Inc., Watertown, Mass.
Jodee Plastic Co., Brooklyn, N. Y.
Jupiter Plastics, Inc., Pittsfield, Mass.
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
•Kingman, E. B. Co., Inc., Leominster, Mass.
Laminated Sheet Products Corp., Norwood, Mass.
Leathertone, Inc., Boston, Mass.
Long, Thomas J., Inc., Carle Place, New York
Lurie Plastics, Inc., Colonial Heights, Va.
Lee, Walter, Chemical Corporation, Bronx, N. Y.
Majestic Creations, Inc., Woodside, N. Y.
Mankato Paper Box Co., Mankato, Minn.
Name Plate Products Co., Philadelphia, Pa.
Ormond Manufacturing Co., Inc., Union City, N. J.
Pelican Plastics, Inc., Homer, Louisiana
Paragon Plastic Corporation, New York
Plasti-Chemical Corp., Miami, Fla.
Perma Seal Plastic Products Co., St. Paul, Minn.
Plasticrafts, Inc., Denver, Colorado
Plastic Innovations, Inc., Yonkers, N. Y.
Plastic Suppliers & Manufacturers, Baton Rouge, La.
Plastic Enterprises, College Point, N.Y.
Plastics, Inc., St. Paul, Minn.
Plastics, Laminates & Fabrics, Inc., Chicago
Premier Plastics Co., Milwaukee, Wisc.
Presco Plastics, Milwaukee, Wisc.
Printloid Plastics, Inc., New York
Reynolds Plastics, Inc., Walled Lake, Mich.
•Sandman, Eli Co., Worcester, Mass.
Shoe Form Co., Inc., Auburn, N. Y.
•Sillcocks-Miller Co., The, Maplewood, N. J.
Southern Plastic Products Co., Riviera Beach, Fla.
Springfield Fabricators, Inc., Springfield, N. J.
Staff Die Cutting Co., New York
•Stricker-Brunhuber Corp., New York
Syracuse Plastic Molders, Syracuse, N. Y.
Timely Products Mfg. Co., Des Moines, Iowa
Todaro, S. Co., Buffalo, N. Y.
•Transilwrap Company, Chicago

•Indicates Advertiser.

United Mask & Nov. Co., Inc., Glendale, N. Y.
U.S. Plastic Products Corp., Metuchen, N. J.
Valley-National Corporation, The, Milldale, Conn.
Virginia Plak Company, New York
Westlake Plastics Company, Lenni Mills, Pa.
Wilmington Fibre Specialty, New Castle, Delaware

DIEMAKERS, EXTRUSION

● Akron Presform Mold Co., Cuyahoga Falls, Ohio
Al-Be Industries, Bell Gardens, Calif.
Conneaut Rubber & Plastics Co., Conneaut, Ohio
● Danielson Manufacturing Co., Danielson, Conn.
Dewes-Gumbs Die Co., Inc., New York
● Egan, Frank W., & Co., Somerville, N. J.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Verese, Italy
Ferriot Bros., Inc., Akron, Ohio
Industrial Eng. Service, South Easton, Mass.
Industrial Plastics Corp., Elkhart, Ind.
● Johnson Manufacturing Co., Chippewa, Wisc.
● Kingman, E. B. Co., Inc., Leominster, Mass.
L & P Tool Company, Cincinnati, Ohio
Many, J. & Co., New York
Nalle Plastics, Inc., Austin, Texas
National Plastics, Inc., Knoxville, Tenn.
● Newark Die Company, Newark, N. J.
Plastic Mold Co., Maywood, Calif.
● Robbins Plastic Machinery Corp., Elkhart, Ind.
● Roehlen Engraving Works, Inc., Rochester, N. Y.
● Sticker-Brunhuber Corp., New York
● Superior Plastics, Inc., Chicago
U. S. Stoneware Co., The, Akron, Ohio
Vern Emery Co., Sun Valley, Calif.
Westlake Plastics Company, Lenni Mills, Pa.
● Windsor, R. H. Limited, Chessington, Surrey England

DIE MAKERS, HIGH FREQUENCY, HEAT SEALING

Accurate Steel Rule Die Mfgs., New York
Allied Engravers, Inc., New York
Artmor Plastics Corp., Cumberland, Maryland
Atlas Plastic Specialties, Inc., Chicago
Barr Corp., Richmond Hill, N. Y.
Electronic Processes Corp., San Francisco, Calif.
Guild Electronics, Inc., New York
● Liberty Cutting Die Co., New York
Manhattan & Electronic Die Co., New York
Plastic Welding Corp., Newark, N. J.
Southern Tool Manufacturing, Winston-Salem, N. C.
● Superior Plastics, Inc., Chicago
Todaro, S. Co., Buffalo, N. Y.
Weld Edge Plastics, Inc., Newark, N. J.

DIP COATING, PLASTIC

● American Agile Corp., Maple Hts., Ohio
American Combining Corp., Queens, N. Y.

● Indicates Advertiser.

Atlas Mineral Products Co., Mertztown, Pa.
Bricmar Manufacturing Corp., New York
Capitol Plastics Co., Inc., Lansing, Mich.
Chemical Development Corp., Danvers, Mass.
Clear View Plastics Corp., Poplar Bluff, Miss.
Dec-Art Process Co., Inc., New York
Electro-Technical Products, Nutley, N. J.
Emerson & Cuming, Inc., Canton, Mass.
Engineered Plastics, Inc., Gibsonville, N. C.
Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio
Fawn Plastics Co., Inc., Baltimore, Md.
Flexible Products Co., Marietta, Ga.
General Plastics Corp., Paterson, N.J.
● Glidden Co., Cleveland
Industrial Sales Engineers, New York
International Plastic, New York
Jupiter Plastics, Inc., Pittsfield, Mass.
L & P. Tool Company, Cincinnati, Ohio
Lami-Plast Products Co., Tampa, Fla.
Lithgow Chemicals Co., Division of Reinhold Engineering & Plastic Co., Norwalk, Calif.
Magic Chemical Company, Brockton, Mass.
● Microcell, Ltd., Low Dow, England
Name Plate Products Co., Philadelphia, Pa.
Navarm Chemical Co., Maywood, Calif.
Pace, F. D. Co., Grand Rapids, Mich.
Plasticrafts, Inc., Denver, Colo.
Plastics, Laminates & Fabrics, Inc., Chicago
Polykote, Inc., Cleveland, Ohio
● Polymer Corp., The, Reading, Pa.
● Polymer Corp., Export Co., Polypenco, Inc., Reading, Pa.
● Polyplastex United, Inc., Union, N. J.
Premier Vacuum Process Corp., Maspeth, N. Y.
Pyramid Industrial Finishing Co., New York
Reinhardt Plastics Company, Denver, Colorado
● Sandman, Eli Co., Worcester, Mass.
Seal-Peel, Inc., Royal Oak, Mich.
Servwell Products Co., The, Cleveland, Ohio
Starlite Plastic Co., Kenmore, N. Y.
Steere Enterprises Inc., Akron, Ohio
Tylene Plastics, Inc., Michigan City, Ind.
U. S. Stoneware Co., Akron, Ohio
Western Coating Co., Royal Oak, Mich.

ELECTRONIC QUILTING

Art Plastics Mfg. Co., Los Angeles, Calif.
Barr Corp., Richmond Hill, N. Y.
Blossom Mfg. Co., New York
● Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass.
Electronic Processes Corp., San Francisco, Calif.
Hunton Plastics Co., Englewood, N. J.
Marbek Inc., Brooklyn, N. Y.

EMBEDDING

A & B Plastics, Seattle, Wash.
Allied Engraving & Stamping Co., Buffalo, N. Y.
American Combining Corp., Queens, N. Y.
Aries Laboratories, Inc., Long Island, N. Y.
Atlas Plastics, Inc., Buffalo, N. Y.
Atlas Plastic Specialties, Inc., Chicago
Bauer, George, Keene, N. H.
Bentek Co., Brooklyn, N. Y.
Berkander, George F., Inc., Providence, R. I.
Biggs, Carl H., Co., Inc., Los Angeles, Calif.
● Boonton Molding Co., Boonton, N. J.
Bricmar Manufacturing Corp., New York
● Cadillac Plastic & Chemical Co., Detroit, Mich.
Calabro Plastics, Upper Darby, Pa.
Clearfloat, Inc., Attle, Mass.
Comet Novelty Co., Adams, Mass.
Conn-Craft Co., Waterbury, Conn.
Conneaut Rubber & Plastics Co., Conneaut, Ohio
● Emeloid Co., Inc., Hillside, N. J.
Emerson & Cuming, Inc., Canton, Mass.
Everlite Corp., Seattle, Wash.
Hanley Plastics Co., St. Louis, Mo.
Haveg Industries, Inc., Wilmington, Delaware
Hes Electrical Manufacturing Corp., El Monte, Calif.
Industrial Sales Engineers, New York
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Leathertone, Inc., Boston, Mass.
Libo Plastics Co., Milwaukee, Wisc.
Norco Plastic Inc., Milwaukee, Wisc.
Pathway Plastic Corp., Mt. Vernon, N. Y.
Plastic Embedments Co., Inc., Attleboro, Mass.
Plasticrafts, Inc., Denver, Colo.
Plastic Inlays Corp., Summit, N. J.
Plastic Pigment Co., Inc., Long Island City, N. Y.
Plastic Laminating Corp., Vaux Hall, N. J.
Reynolds Plastic, Inc., Walled Lake, Mich.
● Scranton Plastic Laminating Corp., Scranton, Pa.
Sommers Plastic Prod. Co., New York
Sorg Paper Company, The, Middletown, Ohio
Starlite Plastic Co., Kenmore, N. Y.
Superior Laminating Co., New York
Technicraft Co., Boston, Mass.
Therm-O-Form Plastics Co., Homewood, Ill.
Wasco Products, Inc., Cambridge, Mass.
Washington Plastics Co., Sharon, Pa.
● Waterbury Companies, Inc., Waterbury, Conn.

EMBOSSING

A. Flexible plastic film and sheeting
B. Rigid Plastic sheets

Acme Laminating & Plastics Co., Detroit, Mich. (*A, B*)
● Acromark Co., Elizabeth, N. J. (*A, B*)
Allied Engraving & Stamping Co., Buffalo, N. Y. (*A, B*)
American Combining Corp., Rockaway Beach, Queens, N. Y. (*A*)
Anorgana, G. M. B. H., New York (*B*)
Art Plastic Mfg., Co., Los Angeles, Calif. (*A*)
Art Plastic Mfg. Co., Los Angeles, Calif. (*A, B*)
Barr Corp., Richmond Hill, N. Y. (*A*)
● Barron, J. E. Plastics, Inc., Cincinnati, Ohio (*A, B*)
Blossom Mfg., Co., New York (*A*)
● Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass. (*A, B*)
Brutier Products Co., Inc., Secaucus, N. J. (*A*)
Canadian Genera-Tower Ltd., Galt, Ontario (*A*)

Complete addresses of companies listed appear on pp. 1123-1149

Canadian Resins & Chemicals Ltd., Montreal, Quebec, Canada (*A*)
Capitol Plastics Co., Inc., Lansing, Mich. (*A, B*)
Carpenter, L. E., & Co., Wharton, N. J. (*A, B*)
●Carroll, J. B., & Co., Chicago (*B*)
Chelsea Mills, Div. of Novelty BB-Co., New York (*A, B*)
Chicago Price Tag Mfg. Co., Chicago (*B*)
Clinwill Plastics, Inc., Buffalo, N. Y. (*A, B*)
●Coating Products, Englewood, N. J. (*A*)
Conneaut Rubber & Plastics Co., Conneaut, Ohio (*A*)
●Cordo Chemical Corp., Norwalk, Conn. (*A*)
Crowl, Charles, Co., El Monte, Calif. (*A, B*)
●Davis, Joseph, Plastics Co., Arlington, N. J. (*B*)
Denver Plastics, Inc., Golden, Col. (*B*)
Dura Plastics of New York, New York (*B*)
Elm Coated Fabrics Co., Inc., New York (*A*)
●Emeloid Co., Inc., Hillside, N. J. (*B*)
●Falge Engineering Corp., Bethesda, Md. (*A, B*)
Farrington Texol Corp., Walpole, Mass. (*A, B*)
Federal Industries, Belleville, N. J. (*A*)
Form-A-Lite, Inc., Northbridge, Mass. (*A, B*)
●General Plastics Corp., Marion, Ind. (*B*)
●General Tire & Rubber Co., Akron, Ohio (*A*)
●Gering Products, Inc., Kenilworth, N. J. (*C*)
Glass, Harry H., & Bros., New York (*B*)
Gorden-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*A*)
Industrial Sales Engineers, New York (*B*)
Jupiter Plastics, Inc., Pittsfield, Mass. (*A, B*)
Kerr, R. W. Plastic Co., Hastings, Nebraska (*B*)
Kerrco Products, Lincoln, Nebraska (*B*)
Leathertone, Inc., Boston, Mass. (*A, B*)
Linehan and Company, Dallas, Texas (*A*)
●M & N Modern Hydraulic Press, Clifton, N. J. (*B*)
Majestic Creations, Inc., Woodside, N. Y. (*B*)
Marbek Inc., Brooklyn, N. Y. (*A, B*)
Navarm Chemical Co., Maywood, Calif. (*A*)
Newark Paraffine & Parchment Paper Co., Newark, N. J. (*A*)
Omaha Plastics Co., Omaha, Nebraska (*B*)
Paragon Plastic Corporation, New York (*B*)
Plastic Innovations, Inc., Yonkers, N. Y. (*A*)
Plastic Laminating Corp., Vaux Hall, N. J. (*A, B*)
●Plaxall, Inc., Long Island City, N. Y. (*B*)
Plicose Mfg. Corp., Brooklyn, N. Y. (*A*)
●Polyplastex United, Inc., Union, N. J. (*A, B*)

●Indicates Advertiser.

Premier Plastics Co., Milwaukee, Wisc. (*B*)
Presco Plastics, Milwaukee, Wisc. (*B*)
Printloid Plastics, Inc., New York (*B*)
Reynolds Plastics, Inc., Walled Lake, Mich. (*B*)
Ridge Printing Co., Ridgefield, N.J.(*A*)
Rondale Company, Inc., The, Roselle, N. J. (*A*)
●Rotuba Extruders, Inc., Brooklyn, N. Y. (*A, B*)
Rudd Plastic Fabrics, Corp., Brooklyn, N. Y. (*A*)
●Scranton Plastic Laminating Corp., Scranton, Pa. (*A, B*)
Shoe Form Co., Inc., Auburn, N. Y. (*B*)
Sommers Plastic Prod. Co., New York (*A*)
South Salem Studios, South Salem, N. Y. (*B*)
Stensgaard, W. L. and Associates, Chicago (*A, B*)
Syracuse Plastic Molders, Syracuse, N. Y. (*B*)
Therm-O-Form Plastics Co., Homewood, Ill. (*A, B*)
Timely Products Mfg. Co., Des Moines, Iowa (*B*)
●United Laminations, Inc., Mayfield, Pa. (*A, B*)
Velveray Corporation, New York (*A*)
●Waljohn Plastics, Inc., Brooklyn, N. Y. (*A, B*)
Weld Edge Plastics, Inc., Newark, N. J. (*A*)
Wellington Print Works, Inc., Trenton, N. J. (*A*)

EXPORTERS AND IMPORTERS

A. Machinery
B. Resins
C. Molding Compounds

●Akron Presform Mold Co., Cuyahoga Falls, Ohio (*A*)
Amco Plastic Materials, Inc., Brooklyn, N. Y. (*B, C*)
●American Molding Powder & Chemical Corp., Brooklyn, N. Y. (*C*)
Atlas-Sandt Corp., New York (*A*)
Baco Co., New York (*A, C*)
Bamberger, Claude P., Inc., Ridgefield Park, N. J. (*B, C*)
Biggs, Carl H. Co., Inc., Los Angeles, Calif. (*C*)
Blane Corp., Canton, Mass. (*C*)
Blum, Paul, Co., Buffalo, N. Y. (*B, C*)
Bricmar Manufacturing Corp., New York (*A*)
British Machine & Foundry Supplies Ltd., Port Washington, N. Y. (*A*)
Canadian Resins & Chemicals Ltd., Montreal, Quebec, Canada (*B, C*)
Chemical Development Corp., Danvers, Mass. (*B, C*)
Chemtron Fiber Glass Co., El Monte, Calif. (*B*)
Collins, Calwell & Dague, Paramount, Calif. (*C*)
●Cosmos Electronic Machine Co., New York
●Danielson Manufacturing Co., Danielson, Conn. (*A, B, C*)
Duke Plastics Corp., Brooklyn, N. Y. (*B*)
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Varese, Italy (*A, B, C*)
●Gering Products, Inc., Kenilworth, N. J. (*C*)
Guild Electronics, Inc., New York (*A*)
●Holland, M., Co., (*C*)
Haveg Industries, Inc., Wilmington, Delaware, (*B, C*)
●Interplastics Corp., New York (*B, C*)
●Omni Products Corp., New York (*A, B, C*)
Oppenheimer Corp., Buffalo, N. Y. (*B, C*)
Plastic Laminating Corp., Vaux Hall, N. J. (*A*)
●Polypenco, Inc., Reading (*B, C*)
●Ringler-Dorin, Inc., New York (*A*)
●Robbins Plastic Machinery Corp., Elkhart, Ind. (*A*)
Rosenthal, Alfred A., New York (*A, C*)
Shuman & Sons, Philip, Buffalo, N. Y. (*B, C*)
Specialty Products Company, Jersey City, N. J. (*C*)
Teal Company, New Haven, Conn. (*C*)
United Sales Service, Los Angeles (*A, B, C*)
●Woloch, George, Co., Inc., (*B, C*)

FABRICATORS

A & B Plastics, Seattle, Wash.
Aacon Industries, Inc., Brooklyn, N. Y.
●Ace Plastic Co., Jamaica, N. Y.
Acme Plastic Products Co., Inc., Horsham, Pa.
Airconductors, Compton, Calif.
Airmate Co., Toledo, Ohio
●Akron Presform Mold Co., Cuyahoga Falls, Ohio
Allied Engraving & Stamping Co., Buffalo, N. Y.
Allied Plasti-Lite Enterprises, Inc., St. Louis, Mo.
●American Agile Corp., Maple Hts., Ohio
American Hard Rubber Co., New York
Ameriplastic Co., Flint, Mich.
Amston Plastic Engineering Co., Amston, Conn.
Aquador Plastics, Inc., Brooklyn, N. Y.
Argo Plastic Products, Cleveland, Ohio
Aristocrat Plastics, Inc., Newark, N. J.
Art Plastic Mfg., Co., Los Angeles, Calif.
●Atkins & Merrill, Inc., Southbury, Mass.
Atlas Mineral Products Co., Mertztown, Pa.
Atlas Plastic Specialties, Inc., Chicago
●Barron, J. E., Plastics, Inc., Cincinnati, Ohio
Beetle, Carl N., Plastics Corp., Fall River, Mass.
Bel-Art Products, West New York, N. J.
Bentek Co., Brooklyn, N. Y.
Ber-Design Associates, Irvington, N. J.
Berkander, George F., Inc., Providence, R. I.
Blackman Plastics, Inc., Culver City, Calif.
●Boltz Products Div., General Tire & Rubber Co., Lawrence, Mass.
●Boonton Molding Co., Boonton, N. J.
Borkland Mfg. Co., Marion, Ind.
Bricmar Manufacturing Corp., New York
Brilhart Plastics Corp., Mineola, N. Y.
Budscraft, Inc., Mpls., Minn.
Burlington Molding Corp., Burlington, N. C.
●Cadillac Plastic & Chemical Co., Detroit, Mich.
Canton Containers, Inc., Canton, Ohio
Capitol Plastics Co., Inc., Lansing, Mich.
Carolina Plastics Co., Charlotte, N. C.
●Carroll, J. B., & Co., Chicago
●Cast Optics Corp., Hackensack, N. J.
Chance, W. R., & Associates, Inc., Waldorf, Maryland
Chatelain Plastics, Findlay, Ohio
Chemold Co., Santa Monica, Calif.
Chemtron Fiber Glass Co., El Monte, Calif.
Chicago Price Tag Mfg. Co., Chicago

Classic Studio, New York
Clear View Plastics Corp., Poplar Bluff, Miss.
Clinwill Plastics, Inc., Buffalo, N. Y.
Colorite Buttons, New York
● Colonial Kolonite Co., Chicago
Colvin-Friedman Co., Springfield, N. J.
Comet Novelty Co., Adams, Mass.
Conn-Craft Co., Waterbury, Conn.
● Connecticut Plastic Products Co., Inc., Waterbury, Conn.
Consolidated Plastic & Mfg. Co., Chicago
● Continental-Diamond Fibre Corp., Newark, Del.
Crook, William A., Co., Inc., Watertown, Mass.
Crystalx Corp., Lenni Mills, Pa.
Curbell, Inc., Buffalo, N. Y.
Curry Arts Molding & Laminiating Co., Scranton, Pa.
● D & R Plastics Welders, Inc., Hazardville, Conn.
Darnell Manufacturing Co., Orange, Va.
Dayton Plastics, Inc., Dayton, Ohio
Del Incorporated, Columbus, Ohio
Denver Plastics, Inc., Golden, Col.
Dilley Mfg. Co., Cleveland, Ohio
Duke Plastics Corp., Brooklyn, N. Y.
Dura Plastics of New York, New York
Durable Plastics Co., Inc., Seattle, Wash.
Duralastic Products Co., Detroit, Mich.
Electro-Chemical Products Corp., Cleveland, Ohio
Electro Plastic Fabrics, Puldski, Va.
Electronic Wave Products, Inc., New York
● Emeloid Co., Inc., Hillside, N. J.
Emerson Plastics Corp., Bronx, N. Y.
Engineered Plastics, Inc., Gibsonville, N. C.
Engineering Plastics Co., Pasadena, Calif.
Erisman, A. C., Phila. Pa.
Evans-Zeier Plastic Co., Madison, Wisc.
Everlite Corp., Seattle, Wash.
Eveready Plastics, Atlanta, Ga.
Fabri-Form Co., Byesville, Ohio
● Fabrico Mfg. Corp., Chicago
● Falge Engineering Corp., Bethesda, Md.
Fairchild Engine & Airplane Corp., Fairchild Guided Missiles, Div., Wyandanch, N. Y.
Falk Glass & Plastic Co., Inc., L. I. C., N. Y.
Fawn Plastics Co., Inc., Baltimore, Md.
● Federal Tool Corp., Chicago
Felsenthal, G., & Sons, Chicago
Fiber Glass Plastic, Inc., Hialeah, Fla.
Forbes Products Corp., Rochester, N. Y.
Fried Novelties, Brooklyn, N. Y.
Garlock Packing Co., Palmyra
● General Plastic Corp., Marion, Ind.
General Plastics Corp., General Fiber, Inc., Div. of General Plastics, Corp., L. A., Calif.
General Plastics Mfg. Co., Tacoma, Wash.
● General Tire, & Ribber Co., Marion, Ind.
Gladwin Plastics, Inc., Atlanta, Ga.
● Goodrich, B. F. Industrial Products Co., Marietta, Ohio
Gotham Plastics Corp., Bronx, N. Y.
Great Lakes Plastic Co., Buffalo, N. Y.
Greene, Ray, & Co., Toledo, Ohio
Gear Industries, Inc., Jamaica, N. Y.
Gregstrom Corp., Cambridge, Mass.
Haas Corp., Mendon, Mich.
Har-E-Dan Engravers, Bklyn., N. Y.
Hathaway Kraemer, Ltd., Kitchener, Ont. Canada
Haveg Industries, Inc., Wilmington, Delaware
Hays Mfg. Co., Erie, Pa.
Hero Mfg. Co., Inc., Middleboro, Mass.
Hollywood Plastic Arts, Los Angeles
Homalite Co., Wilmington, Delaware
● Hopp Plastics, New York
Hunton Plastics Co., Englewood, N. J.
Imperial Industries, Inc., Wayne, Mich.
Industrial Plastic Fabricators, Inc., Norwood, Mass.
Industrial Plastics Corp., Elkhart, Ind.
Industrial Plastic Supply Div., W. Hartford, Conn.
Industrial Sales Engineers, New York
Insulating Fabricators of New England, Inc., Watertown, Mass.
International Plastic, New York
Jodee Plastic Co., Brooklyn, N. Y.
Jupiter Plastics, Inc., Pittsfield, Mass.
Just Plastics, Inc., New York
Kabar Manufacturing Corp., New York City
Kehr Products Company, Philadelphia, Pa.
● Keolyn Plastics, Inc., Chicago
Kerr Plastic Co., R. W. Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Keystone Plastic Eng. Co., Chicago
Klise Manufacturing Company, Grand Rapids, Mich.
Laminated Sheet Products Corp., Norwood, Mass.
Lami-Plast Products Co., Tampa, Fla.
Lee, Walter Chemical Corp., Bronx, N. Y.
● Lincoln Molded Plastics, Inc., Circleville, Ohio
Long, Thomas J. Inc., Carle Place, N. Y.
Linehan and Company, Dallas, Texas
Lustra-Cite Industries, Inc., Brooklyn, N. Y.
Luzerne Rubber Co., Trenton, N. J.
MacDonald Manufacturing Company, New Baltimore, Mich.
Majestic Creations, Inc., Woodside, N. Y.
Malco Plastics, Inc., Baltimore, Md.
Mankato Paper Box Co., Mankato, Minn.
McClarin Plastics, New Oxford, Penna.
McMillan Industrial Corp., Ipswich, Mass.
● Mico Instrument Co., Cambridge, Mass.
● Microcell, Ltd., Low Dow, England
Multiplastics, Div. of Curd Enterprises, Addison, Ill.
Murray Plastics Company, Poughkeepsie, N. Y.
● Mico Instrument Co., Cambridge, Mass.
● Modern Plastics, Miami, Fla.
Name Plate Products Co., Philadelphia, Pa.
● National Vulcanized Fibre Co., Wilmington, Delaware
Nichols Products Co., Inc., Moorestown, N. J.
Niles Corporation, South Bend, Indiana
Omaha Plastics Co., Omaha, Nebraska
Ormond Manufacturing Co., Inc., Union City, N. J.
Orna Plastics Co., Los Angeles
Pelican Plastics, Inc., Homer, La.
Paragon Plastic Corporation, New York
Pacific Plastics Co., Inc., Seattle, Washington
Pacific Plasti-Fab Corp., San Carlos, Calif.
Pine-Wood Plastic Co., Inc., Cambridge, Mass.
Pioneer Valley Plastics Co., Chicopee, Mass.
Plastic Creators, Inc., Little Perry, N. J.
Plastic Center, Rochester, N. Y.
Plastic Artisans, Inc., Port Chester, N. Y.
Plastic Age Sales, Inc., San Fernando, Calif.
Plastic-Embedments Co., Inc., Attleboro, Mass.
Plasti-Vue, Whitestone, N. Y.
Plasti-Line, Inc., Knoxville, Tenn.
Plasti-Chemical Corp., Miami, Fla.
Plast-Ad Mfg. Co., South Bend, Ind.
Plas-Steel Products, Inc., Walkerton, Ind.
Plastic Center of Texas, San Antonio, Texas
Plastic Engineering Co., Pawtucket, R. I.
Plastic Engineering Co., Tulsa, Oklahoma
Plastic Fabricators, New York
Plastic Innovations, Inc., Yonkers, N. Y.
Plastic Model Engineering Co., Van Nuys, Calif.
Plastic Parts Corporation, Maumee, Ohio
Plastic Process Company, Los Angeles
Plasticrafts, Inc., Denver, Colo.
Plastic Suppliers & Manufacturing, Baton Rouge, La.
Plastics, Inc., St. Paul, Minn.
Plastics, Laminates & Fabrics, Inc.
Plastimayd Products Corporation, Portland, Oregon
Plastofilm, Inc., Wheaton, Ill.
● Plaxall, Inc., Long Island City, N. Y.
● Plura Plastics, Maplewood, N. J.
Polo Plastics Co., Milwaukee, Wisc.
● Polygon Plastic Company, Walkerton, Ind.
● Polymer Corp. The, Reading, Pa.
● Polypenco, Inc., Reading, Pa.
Portz Plastics & Fibre Co., Milwaukee, Wisc.
Post Electric Co., Inc., Andover, N. J.
Premier Plastics Co., Milwaukee, Wisc.
Premier Plastic Mfg., Co., Minneapolis, Minn.
Primloid Plastics, Inc., New York
Production Aid, Inc., Middletown, Ky.
Protective Lining Corp., Brooklyn, N. Y.
Quick Plastics, Jackson, Mich.
Ray Products Co., Inc., Alhambra, Calif.
Raybestos-Manhattan, Inc., Reinforced Plastics Dept., Manheim, Pa.
Raybestos-Manhattan, Inc., Passaic, N. J.
Reinhardt, J. A. & Co., Mountainhome, Penna.
Regal Plastic Co., Kansas City, Mo.
Ren Plastics, Inc., Lansing, Mich.
Reynolds Plastics, Inc., Walled Lake, Mich.
Sajar Plastics, Inc., Middlefield, Ohio
● Sandman, Eli Co., Worcester, Mass.
Schori Process, Division of Ferro-co Corp., Long Island City, N. Y.
● Schwab Plastics Corp., Detroit, Mich.
● Scranton Plastic Laminating Corp., Scranton, Pa.
Sealview Plastics, Inc., Wayne, Pa.
Sealy Plastics, Corp., Rockville, Conn.
Shaw-Randall Co., Inc., Pawtucket, R.I.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149.

Shoe Form Co., Inc., Auburn, N. Y.
Silicone Insulation, Inc., Bronx, N. Y.
•Sillcocks-Miller Co., The, Maplewood, N. J.
South Salem Studios, South Salem, N. Y.
Southeastern Sales Corp., St. Petersburg, Fla.
Southern Plastic Products Co., Riviera Beach, Fla.
Spaulding Fibre Company, Inc., Tonawanda, N. Y.
Sperzel Co., Minneapolis, Minn.
Standard Plastics, Inc., Breingsville, Pa.
Standard Pyoxoloid Corp., Leominster, Mass.
Starline Products, Los Angeles
Starlite Plastic Co., Kenmore, N. Y.
Star Mfg., Inc., Little Ferry, N. J.
Steiner Plastics Mfg. Co., Inc., Glen Cove, N. Y.
Stricker, Carl, Bloomfield, N. J.
•Stricker-Brunhuber Corp., New York
Strick Plastics, Per Kosie, Pa.
Superior Laminating Co., New York
•Superior Plastics, Inc., Chicago
Synthane Corp., Oaks, Pa.
T. O. Plastics, Minneapolis, Minn.
Technicraft Co., Boston, Mass.
Thombert, Inc., Newton, Iowa
Timely Products Mfg. Co., Des Moines, Iowa
Transplastics Fabricating Co., Boston, Mass.
Tulsa Plastics, Tulsa, Okla.
Tumble-Buff Laboratories, Inc., Jamaica, N. Y.
United Sales Service, Los Angeles
United Mask & Nov. Co., Inc., Glendale, N. Y.
Urrite Plastics Fabricators, Pico, Calif.
Universal Moulded Products Corporation, Bristol, Va.
•Vacuum Plastics Corporation, Columbus, Ohio
Valley-National Corporation, The, Milldale, Conn.
•Van Dorn Iron Works Co., Cleveland, Ohio
Virginia Plak Company, New York
Voges Manufacturing Co., Inc., Ozone Park, N. Y.
Wachter Plastic Co., Sacramento, Calif.
Wal-Mar Plastics, Inc., Torrance, Calif.
Wama Company, The, Baltimore, Md.
Weber Plastics, Inc., Stevens Point, Wisc.
Wessel, Stanley & Company, Chicago
Western Plastic, Inc., Spokane, Washington
Westlake Plastics Company, Lenni Mills, Pa.
Wilmington Fibre Specialty, New Castle, Delaware
Winner Mfg. Co., Inc., Trenton, N. J.
Wyatt's Plastics, Inc., Houston, Texas
Wilson Plastics, Inc., Sandusky, Ohio
Young, Machinery Co., The, Muncy, Pa.
Zenith Plastics Co., Ypsilanti, Mich.

FABRICATORS, EXPANDED PLASTICS

A. C. Erisman, Phila., Pa.
Airconductors, Compton, Calif.
Allied Engraving & Stamping Co., Buffalo, N. Y.
Ameriplastic Co., Flint, Mich.
Art Plastic Mfg. Co., Los Angeles, Calif.
Atkins & Merrill, Inc., Southbury, Mass.
Barr Corp., Richmond Hill, N. Y.
Carroll, J. B., & Co., Chicago
Chance, W. R., & Associates, Inc. Waldorf, Maryland
Chemtron Fiber Glass Co., El Monte, Calif.
Clinwill Plastics, Inc., Buffalo, N. Y.
Crystalx Corp., Lenni Mills, Pa.
Curbell, Inc., Buffalo, N. Y.
Dayton Plastics, Inc., Dayton, Ohio
Dyfoam Corp., New Castle, Pa.
Emerson Plastics Corp., Bronx, N. Y.
Fabri-For Co., Byesville, Ohio
Fabri-Kal Corp., Kalamazoo, Mich.
Foam King, Inc., Bronx, N. Y.
Laminated Sheet Products Corp., Norwood, Mass.
Frank Plastics Corp., Detroit, Mich.
General Plastics Mfg. Co., Tacoma, Wash.
Haveg Industries, Inc., Wilmington, Delaware
Jupiter Plastics, Inc., Pittsfield, Mass.
Keystone Plastic Eng. Co., Chicago
Lee, Walter Chemical Corporation, Bronx, N. Y.
Mechtronics, Philadelphia, Pa.
•Microcell, Ltd., Low Dow, England
Multiplastics, Div. of Curd Enterprises, Addison, Ill.
Nesbit Industries, Inc., Chicago
•Perry Plastics, Inc., Erie, Pa.
Plastic Age Sales, Inc., San Fernando, Calif.
Plastics, Laminates & Fabrics, Inc., Chicago
Rondale Company, Inc., The, Roselle, N. J.
•Schwab Plastics Corp., Detroit
Sealy Plastics, Corp., Rockville, Conn.
Strick Plastics, Per Kosie, Pa.

FLAME SPRAYING, PLASTIC

•American Agile Corp., Maple Hts., Ohio
American Combining Corp., Rockaway Beach, Queens, N. Y.
Gusmer, A., Inc., Stalpic Div., Woodbridge, N. J.
Ideal Gold Stamp Co., New York
Lithgow Chemicals Co., Division of Reinhold Engineering & Plastic Co., Norwalk, Calif.
Plasticrafts, Inc., Denver, Colo.
Schori Process, Division of Ferro-co Corp., Long Island City, N. Y.

HEAT SEALING, PLASTIC FILM AND SHEET

A & B Plastics, Seattle, Wash.
Aacon Industries, Inc., Brooklyn, N. Y.
Acme Laminating & Plastics Co., Detroit, Mich.
•Akron Presform Mold Co., Cuyahoga Falls, Ohio
Allied Engraving & Stamping Co., Buffalo, N. Y.
Alvimar Mfg. Co., New York
American Combining Corp., Rockaway Beach, Queens, N. Y.
Amerioplastic Co., Flint, Mich.
•Amos Packaging Co., Edinburg, Ind.
•Anorgana G.M.B.H., München, Germany
Aquador Plastics, Inc., Brooklyn, N. Y.
Argo Plastic Products, Cleveland, Ohio
Art Plastics Mfg. Co., Los Angeles, Calif.
Artmor Plastics Corp., Cumberland, Maryland
Barr Corp., Richmond Hill, N. Y.
Bel-Art Products, West New York, N. J.
Blossom Mfg. Co., New York
•Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass.
Borkland Mfg. Co., Marion, Ind.
•Cadillac Plastic & Chemical Co., Detroit, Mich.
Canton Containers, Inc., Canton, Ohio
•Carroll, J. B., & Co., Chicago
Chelsea Mills, Div. of Novelty BB-Co., New York
Cheslam Corp., Yonkers, N. Y.
Classic Studio, New York
Colvin-Freidman Co., Springfield, N. J.
Cox Plastics Corp., Buffalo, N. Y.
Crystalx Corp., Lenni Mills, Pa.
•D & R Plastic Welders, Inc., Hazardville, Conn.
Darnell Manufacturing Co., Orange, Va.
Dura-Lee Corp., Kansas City, Miss.
Electro Plastic Fabrics, Puldski, Va.
Electonic Processes Corp., San Francisco
Electronic Wave Products, Inc., New York
•Fabrico Mfg. Corp., Chicago
Farrington Texel Corp., Walpole, Mass.
•Federal Tool Corp., Chicago
Flexible Products Co., Marietta, Ga.
Forbes Products Corp., Rochester, N. Y.
Gilman, Marty, Inc., Gilman, Conn.
•H. & R. Industries, Nazareth, Pa.
Haveg Industries, Inc., Wilmington, Delaware
•Ideal Plastics, Div. Ideal Toy Corp., Hollis, N. Y.
Industrial Plastic Supply Div., W. Hartford, Conn.
Jupiter Plastics, Inc., Pittsfield, Mass.
Kabar Manufacturing Corp., New York City
Kehr Products Company, Philadelphia, Pa.
•Liberty Cutting Die Co., New York
•Microcell, Ltd., Low Dow, England
Name Plate Products Co., Philadelphia, Pa.
Navarm Chemical Co., Maywood, Calif.
Nebraska Plastics, Inc., Cozad, Nebraska
Niagara Plastics Co., Inc., Erie, Penna.
Omaha Plastics Co., Omaha, Nebraska
Plastic Creators, Inc., Little Perry, N. J.
Plastic Artisans, Inc., Port Chester, N. Y.
Plast-Ad Mfg. Co., South Bend, Ind.
Pioneer Valley Plastics Co., Chicopee, Mass.
Plasticrafts, Inc., Denver, Colo.
Plastic Innovations, Inc., Yonkers, N. Y.
Plastics, Laminates & Fabrics, Inc., Chicago
Plastimayd Products Corporation, Portland, Oregon
•Plaxall, Inc., Long Island City, N. Y.
Plicose Mfg., Corp., Brooklyn, N. Y.
Polo Plastics Co., Milwaukee, Wisc.
Poly Plastic Products, Inc., Paterson, N. J.
Precision Coating Co., Inc., Needham, Mass.
Production Aid, Inc., Middletown, Ky.
Protective Lining Corp., Brooklyn, N. Y.
Sealview Plastics, Inc., Wayne, Pa.
Shaw-Randall Co., Inc., Pawtucket, R. I.
Shoe Form Co., Inc., Auburn, N. Y.
Skyline Industries, Titusville, Pa.
Sorg Paper Company, The, Middletown, Ohio
Sperzel Co., Minneapolis, Minn.

•Indicates Advertiser.

Springfield Fabricators, Inc., Springfield, N. J.
W. & A. Co., Inc., Attleboro, Mass.
Waltco Products, Inc., Chicago
Weld Edge Plastics, Inc., Newark, N. J.
Western Plastic, Inc., Spokane, Washington

HEAT TREATING OF POLYETHYLENE FOR PRINTING

American Combining Corp., Rockaway Beach, Queens, N. Y.
Art Plastics Mfg. Co., Los Angeles, Calif.
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada
Canton Containers, Inc., Canton, Ohio
Cee-Jay Extruders, Inc., New Hyde Park, N. Y.
Dec-Art Process Co., Inc., New York
●Egan, Frank W., & Co., Somerville, N. J.
●H. & R. Industries, Nazareth, Pa.
Ideal Gold Stamping Co., New York
●Microcell, Ltd., Low Dow, England
Permanent Label Corp., Bloomfield, N. J.

HOBBING

ABA Tool & Die Co., Inc., Manchester, Conn.
Ace Tool & Mfg. Co., Newark, N. J.
Aetna Plastics Die Corp., Chicago
Allied Engravers, Inc., New York
Baco Co., New York
Buttondex Corp., New York
●Byrd Plastics, Inc., Erie, Pa.
●Cadillac Plastic & Chemical Co., Detroit, Mich.
Colt's Plastics Co., Inc., Hartford, Conn.
Damon Tool & Engineering Co., Chicago
●Danielson Manufacturing Co., Danielson, Conn.
●Eagle Tool & Machine Co., Hillside, N. J.
Helmuth Tool & Die Co., Linden, N. J.
Industrial Eng. Service, South Easton, Mass.
●Liberty Tool & Machine Co., Irvington, N. J.
●M & N Modern Hydraulic Press, Clifton, N. J.
Metalmasters, Inc., Chicago
●Midland Die & Engraving Co., Division of Prex Corp., Franklin Park, Ill.
Modern Molders, Inc., Kenilworth, N. J.
Modern Tool & Die Co., Inc., Leominster, Mass.
Mojave Die & Engraving, Los Angeles
Moldcraft, Inc., Baltimore, Md.
National Plastics, Inc., Knoxville, Tenn.
●Newark Die Company, Newark, N. J.
●Newark Die Hobbing & Casting Co. Newark, N. J.
Parker-Hartford Corp., The, Hartford, Conn.
Plastic Mold Co., Maywood, Calif.
Primas Moldmakers, Inc., Buffalo, N. Y.
Process Mold Co., Detroit, Mich.
Reinhold-Geiger Plastics, Inc., Los Angeles
●Sierra Electric Corp., Gardena, Calif.
Southern Tool Manufacturing, Winston-Salem, N. C.
●Standard Tool Co., Leominster, Mass.
●Stricker-Brunhuber Corp., New York
Zapf, Charles, & Co., Evanston, Ill.

KELLERING

●Eagle Tool and Machine Co., Hillside, N. J.
●Newark Die Co., Newark, N. J.
Paxton Kellering Co., Glendale, N. Y.

METALLIZING (Custom)

A. *Flexible plastic film*
B. *Rigid Plastic Sheets*
C. *Molded plastic products (novelties, closures, toys, etc.)*

Aacon Industries, Inc., Brooklyn, N. Y. (*B, C*)
Adams Plastic Products, Cincinnati, Ohio (*C*)
●Akron Preform Mold Co., Cuyahoga Falls, Ohio (*C*)
American Combining Corp., Rockaway Beach, Queens, N. Y. (*A*)
Augusta Plastics, Inc., Bronx, N. Y. (*C*)
Berkander, George F., Inc., Providence, R. I. (*C*)
Blossom Mfg. Co., New York (*A*)
Brook Molding Corp., Norwood, Mass. (*C*)
Brutler Products Co., Inc., Secaucus, N. J. (*A*)
Campro Co., Canton, Ohio (*C*)
Clear View Plastics Corp., Poplar Bluff, Miss. (*B, C*)
●Coating Products, Englewood, N. J. (*A*)
Coham Epner Co., Inc., New York (*C*)
●Connecticut Plastic Products Co., Inc., Waterbury, Conn. (*C*)
Continental Can Co., Inc., Mt. Vernon, Ohio (*A*)
Cruver Mfg. Co., Chicago (*C*)
Dorrie Process Co., Inc., Brooklyn, N. Y. (*A*)
Electrochemical Inds., Worcester, Mass. (*C*)
●Erie Resistor Corp., Erie, Pa. (*C*)
Eyelet Specialty Co., Waterbury, Conn. (*C*)
Felsenthal, G., & Sons, Chicago (*C*)
Fiber Glass Plastic, Inc., Hialeah, Fla. (*B*)
G & T Manufacturing Co., New Britain, Conn. (*A, B*)
Gits Molding Corp., Chicago (*C*)
Glass Laboratories, Inc., Brooklyn, N. Y. (*A*)
Gomar Manufacturing Co., Inc., Linden, N. J. (*A, B*)
Hy-Sil Mfg. Co., Revere, Mass. (51) (*A, B*)
●Ideal Plastics, Div. Ideal Toy Corp., Hollis, N. Y. (*C*)
●Lincoln Molded Plastics, Inc., Circleville, Ohio (*C*)
●McKesson & Robbins, Incorporated, New York (*A, B, C*)
Metallized Products Co., Norwalk, Conn. (*A*)
Michigan Panelyte Molded Plastics, Inc., Dexter, Mich. (*C*)
●Mimosa Corp., Cardinal Div., Evansville, Ind.
Mitchell Plastics, Inc., Owosso, Mich. (*C*)
Modern Molders, Inc., Kenilworth, N. J. (*C*)
●National Plastic Products Co., The, Odenton, Mo. (*C*)
National Vacuum Platers, Inc., Philadelphia, Pa. (*B, C*)
Norco Plastic Inc., Milwaukee, Wisc. (*C*)
Planet Plating Co., Inc., Brooklyn, N. Y. (*C*)
Plastic Academy Products Corp., Leomister, Mass. (*C*)
Plastic Engineering Co., Pawtucket, R. I. (*B, C*)
Plastic Inlays Corp., Summit, N. J. (*C*)
Premier Vacuum Process Corp., Maspeth, N. Y. (*B, C*)
●Santay Corporation, Chicago (*C*)
●Sinko Mfg. & Tool Co., Chicago (*C*)
Stimsonite Div. Elastic, Stop Nut Corp. of America, Chicago (*C*)
●Swedlow Plastics, Co., Los Angeles (*B, C*)
Swenson, V. H. Co., Inc., Arlington, N. J. (*C*)
Timely Products Mfg. Co., Des Moines, Iowa (*C*)
Trivac Company, Div. of Specialized Plating Co., Los Angeles (*C*)
●20th Century Plastics Co., Chicago (*C*)
Vac-Art, Incorporated, Bay City, Mich. (*B, C*)
Vacuum Metalizing Corporation, Long Island City, N. Y. (*C*)
W & A Co., Inc., Attleboro, Mass. (*C*)
Washington Plastic Co., Sharon, Pa. (*C*)
Welch Plastics & Mfg. Co., Inc., Columbus, Ohio (*C*)
Wellington Print Works, Inc., Trenton, N. J. (*A*)

MODEL MAKERS

A & B Plastics, Seattle, Wash.
ABA Tool & Die Co., Inc., Manchester, Conn.
Ace Plastic Molding Corp., I. C., N. Y.
Ace Tool Mfg., Co., Newark, N. J.
A. C. Erisman, Phila., Pa.
●Akron Preform Mold Co., Cuyahoga Falls, Ohio
Allied Engraving & Stamping Co., Buffalo, N. Y.
●American Agile Corp., Maple Hts., Ohio
American Molding Co., San Leandro, Calif.
Amston Plastic Engineering Co., Amston, Conn.
Arnkurt Associates Engineers, New York
●Artag Plastics Corp., Chicago
Atkins & Merrill, Inc., Southbury, Mass.
Atlas Plastics, Inc., Little Ferry, N. J.
Baco Co., New York
Bacon & Weber, Chicago
Ber-Design Associates, Irvington, N. J.
Bergen Mold & Engineering Co., Little Ferry, N. J.
Bernard Plastics Molding Corp., Long Island City, N. Y.
●Blackhawk Molding Co., Inc., Addison, Ill.
Bricmar Manufacturing Corp., New York
Brook Molding Corp., Norwood, Mass.
Budd, John, Eastford, Conn.
Caco, Inc., Pomona, Calif.
●Cadillac Plastic & Chemical Co., Detroit, Mich.
Campro Co., Canton, Ohio
Capitol Plastics Co., Inc., Lansing, Mich.
Carolina Plastics Co., Charlotte, N. C.
Chaney Plastic Molding Co., Denver, Colorado
Classic Studio, New York
Colorite Buttons, New York
Conn-Craft Co., Waterbury, Conn.
Curry Arts Molding & Laminating Co., Scranton, Pa.
Damac Tool Co., Bronx, N. Y.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149.

●Danielson Manufacturing Co., Danielson, Conn.
Del Incorporated, Columbus, Ohio
●Dillon Beck Mfg. Co., Hillside, N. J.
Dura Plastics of New York, New York
●Engelking Patterns, Inc., Columbus, Ind.
Evans-Zeier Plastic Co., Madison, Wisc.
Fabri-Form Co., Byesville, Ohio
Ferriot Bros., Inc., Akron, Ohio
Gary Enterprises, Inc., Brooklyn, N. Y.
Gershon, Irvin J., Industrial Design, Maplewood, N. J.
Gore, Fred M., Industrial Design, Dallas, Texas
Guild Molders, Inc., Armonk, New York
●H. M. S. Associates, Willow Grove, Pa.
Harvey, Guy P., & Son Corp., Leominster, Mass.
Haveg Industries, Inc., Wilmington, Delaware
Hydrawlik, Roselle, N. J.
Industrial Eng. Service, South Easton, Mass.
Industrial Plastic Supply Div., W. Hartford, Conn.
Kock, Henry Associates, Pasadena, Calif.
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
●Kingman, E. B. Co., Inc., Leominster, Mass.
Kunst, The John Company, New York
Lustro-Cite Industries, Inc., Brooklyn, N. Y.
Metalmold Forming Co., New York
Murdoch, Colin D., San Leandro, Calif.
Mojave Die & Engraving, Los Angeles
Neken, William, Los Angeles
Nu-Engineering, Inc., Ferndale, Mich.
Paragon Plastic Corporation, New York
Plastics Center of Texas, San Antonio, Texas
Plastics, Inc., St. Paul, Minn.
Plastic Tooling Aids Laboratory, Bridgeport, Conn.
Plastic Mold Co., Maywood, Calif.
Plastic Model Engineering Co., Van Nuys, Calif.
Plastic Suppliers & Manufacturers, Baton Rouge, La.
Plastics, Laminates & Fabrics, Inc., Chicago
●Plura Plastics, Maplewood, N. J.
Poliner, William, W. Englewood, N. J.
Polymold Plastics, Inc., Chicago
Portz Plastics & Fibre Co., Milwaukee, Wisc.
Premier Plastics Co., Milwaukee, Wisc.
Presco Plastics, Milwaukee, Wisc.
Production Aid, Inc., Middletown, Ky.
Reinhold-Geiger Plastics, Inc., Los Angeles
●Reliance Pattern Works, Chicago
Ren Plastics, Inc., Lansing, Mich.
Resolite Corporation, Zelienople, Pa.
Reynolds Plastics, Inc., Walled Lake, Mich.
Rhodes, Philip H. & Associates, Cincinnati, Ohio
Roger's Product Design, Leominster, Mass.
Romar Plastics, Inc., St. Charles, Ill.
Rosenthal, Alfred A., New York
●Santay Corporation, Chicago
Sarcol Foundry & Pattern Corp., Chicago
Singer, Lawrence H. Designer, New York
●Sierra Electric Corp., Gardena, Calif.
Singer, Lawrence H. Industrial Design, Jericho, N. Y.
●Sinko, Mfg. & Tool Co., Chicago
South Salem Studios, South Salem, N. Y.
Southern Plastics Engineering Corp., Greensboro, N. C.
Southern Tool Manufacturing, Winston-Salem, N. C.
Springfield Cast Products, Inc., Springfield, Mass.
●Standard Tool Co., Leominster, Mass.
Stricker, Carl, Bloomfield, N. J.
●Stricker-Brunhuber Corp., New York
●Superior Plastics, Inc., Chicago
Syracuse Plastic Molders, Syracuse, N. Y.
Technicraft Co., Boston, Mass.
Timely Products Mfg. Co., Des Moines, Iowa
United Die Molders Inc., Chicago
Urrite Plastics Fabricators, Pico, Calif.
●Vacuum Plastics Corporation, Columbus, Ohio
Vavrik-Industrial Design, Louis, Rossford, Ohio
W & A Co., Inc., Attleboro, Mass.
●Waterbury Companies, Inc., Waterbury, Conn.

●Indicates Advertiser.

MOLD MAKERS, CAST

A. *Beryllium Copper*
B. *Aluminum*
C. *Ferrous Metals*
D. *Plastics*

A & B Plastics, Seattle, Wash. (*D*)
ABA Tool & Die Co., Inc., Manchester, Conn. (*A, B, C, D*)
A. S. K., Mfg. Co., Phila., Pa. (*A, D*)
Ace Plastic Molding Corp., L.I.C., N. Y. (*A, D*)
Ace Tool & Mfg., Co., Newark, N. J. (*A*)
Akromold, Inc., Akron, Ohio (*A, B, C*)
●Akron Preform Mold Co., Cuyahoga Falls, Ohio (*B, D*)
Anderson Die & Mfg. Co., Portland, Oregon (*C*)
Atkins & Merrill, Inc., Southbury, Mass. (*D*)
Altas Plastics, Inc., Little Ferry, N. J. (*A, C*)
Ber-Design Associates, Irvington, N. J. (*A, B, D*)
Bergen Mold & Engineering Co., Little Ferry, N. J. (*A, C*)
●Blackhawk Molding Co., Inc., Addison, Ill. (*D*)
Bondy Engineering Co., Brooklyn, N. Y. (*A*)
British Machine & Foundry Supplies, Ltd., Port Washington, N. Y. (*A, C*)
Chemtron Fiber Glass Co., El Monte, Calif. (*B, D*)
●Chili Plastics, Inc., N. Chili, N. Y. (*A, C*)
Colt's Plastics Co., Inc., Hartford, Conn. (*C, D*)
Crown Machine & Tool Co., Fort Worth, Texas (*D*)
Cuming, M. A., & Co., Inc., New York (*B*)
Damac Tool Co., Bronx, N. Y. (*A*)
Damen Tool & Engineering Co., Chicago (*A, C, D*)
●Danielson Manufacturing Co., Danielson, Conn. (*A, C*)
Duralastic Products Co., Detroit, Mich. (*D*)
Enduro Tool & Engineering Co., Chicago (*A*)
●Engelking Patterns, Inc., (*B, C, D*)
●Federal Tool Corp., Chicago (*A, D*)
Ferriot Bros., Inc., Akron, Ohio (*A, B*)
Fortney Manufacturing Co., Inc., Newark, N. J. (*A*)
Gary Enterprises, Inc., Brooklyn, N. Y. (*A, D*)
Goulding Mfg., Co., Saginaw, Mich. (*B*)
Gulliksen, Wm. M., Mfg., Co., Hills, Mass. (*D*)
Harvey, Guy P., & Son Corp., Leominster, Mass. (*A*)
Haveg Industries, Inc., Wilmington, Delaware, (*D*)
The Herblin Corp., Glen Cove, N. Y. (*D*)
Houghton Laboratories, Inc., Olean, N. Y. (*D*)
Industrial Eng. Service, South Easton, Mass. (*A, B, C, D*)
Kellering, Victor, Inc., Brooklyn, N. Y. (*A, B, C*)
Kerr, R. W., Plastic Co., Hastings, Nebraska (*D*)
Kerrco Products, Lincoln, Nebraska (*D*)
Keystone Plastic Eng. Co., Chicago, (*D*)
Kunst, The John Company, New York (*D*)
Lami-Plast Products Co., Tampa, Fla. (*D*)
MacDonald Manufacturing Company, New Baltimore, Mich. (*D*)
Manco Products Inc., Melvindale, Mich. (*A*)
Many, J. & Co., New York (*A, C*)
Meriden Molded Plastics, Inc., Meriden, Conn. (*D*)
Metalmasters, Inc., Chicago (*A*)
Metalmold Forming Co., New York (*D*)
●Microcell, Ltd., Low Dow, England (**D**)
Multiplastics, Div. of Curd Enterprises, Addison, Ill. (*D*)
Modern Molders, Inc., Kenilworth, N. J. (*A*)
Mojave Die & Engraving, Los Angeles, (*C*)
●Molded Products, Division of Admiral Corp., West Chicago (*D*)
●Newark Die Company, Newark, N. J (*A*)
●Newark Die Hobbing & Casting Co., Newark, N. J. (*A, C*)
Norco Plastics, Inc., Milwaukee, Wisc. (*D*)
Oak Engineering Co., Inc., Gloucester City, N. J. (*B, D*)
Paragon Plastic Corporation, New York (*B*)
Pitman Plastic Products, Inc., Pitman, N. J. (*D*)
●Plasticrafters, Inc., Chicago (*D*)
Plastic Enterprises, College Point, N. Y. (*D*)
Plastic Tooling Aids Laboratory, Bridgeport, Conn. (*C, D*)
Polymold Plastics, Inc., Chicago (*D*)
Premier Plastics Co., Milwaukee, Wisc. (*D*)
Process Mold Co., Detroit, Mich. (*A, B*)
Reinhardt Plastics Company, Denver, Colorado (*A, B, D*)
Ren Plastics, Inc., Lansing, Mich. (*D*)
Reynolds Plastics, Inc., Walled Lake, Mich. (*D*)
Rochelle Plastic Mold Co., Inc., Clifton, N. J. (*A*)
Royal Mfg. Co., Prescott, Arizona (*A, B*)
●Santay Corporation, Chicago (*D*)
Sarcol Foundry & Pattern Corp. Chicago (*B, D*)
Specialty Resins, Inc., Chicago (*A*)
Springfield Cast Products, Inc., Springfield, Mass. (*B*)

●Standard Tool Co., Leominster, Mass. (*A, B, C*)
Strabeg Machine Company, Bronx, N.Y. (*A*)
●Stricker-Brunhuber Corp., New York (*A, B, C, D*)
●Superior Plastics, Inc., Chicago (*A, B, D*)
Syracuse Plastic Molders, Syracuse, N. Y. (*B, D*)
Una-Craft Engineering Co., Inc., Hazel Park, Mich. (*A*)
United Mask & Nov. Co., Inc., Glendale, N. Y. (*B, D*)
United Tool Company, Bridgeport, Conn. (*D*)
●Vacuum Plastics Corporation, Columbus, Ohio (*D*)
Voges Manufacturing Co., Inc., Ozone Park, N. Y. (*A*)
W & A Co., Inc., Attleboro, Mass. (*A, C, D*)
Wal-Mar Plastics, Inc., Torrance, Calif. (*D*)
Washington Plastics Co., Sharon, Pa. (*D*)
●Waterbury Companies, Inc., Waterbury, Conn. (*D*)
●Windsor, R. H. Limited, Chessington, Surrey England (*D*)
Winner Mfg., Co., Trenton, N. J. (*D*)
Zapf, Charles, & Co., Evanston, Ill. (*A*)

MOLD MAKERS, ELECTROFORMING

ABA Tool & Die Co., Inc., Manchester, Conn.
●Akron Presform Mold Co., Cuyahoga Falls, Ohio
Camin Laboratories, Inc., Brooklyn, N. Y.
Carpenter, L. E., & Co., Wharton, N. J.
●Chromium Corp. of America, New York
Damac Tool Co., Bronx, N. Y.
Damen Tool & Engineering Co., Chicago
●Electromold Corp., Trenton, N. J.
Great Lakes Plastic Co., Buffalo, N. Y.
Hartland Plastics, Inc., Hartland, Wisc.
●Jay Company, T. V., Chicago
Parker-Hartford Corp., The, Hartford, Conn.
Planet Plating Co., Inc., Brooklyn, N. Y.
●Plating Eng., Co., Milwaukee, Wisc.
Reinhardt Plastics Company, Denver, Colorado
●Ringler-Dorin, Inc., New York
●Superior Plastics, Inc., Chicago
Timely Products Mfg., Co., Des Moines, Iowa
Ultra Electro Forming & Mfg., Co., Pitman, N. J.
W & A Co., Inc., Attleboro, Mass.
●Zapf, Charles & Co., Evanston, Ill.

MOLD MAKERS, METAL SPRAYING

●Akron Presform Mold Co., Cuyahoga Falls, Ohio
Kerr, R. W. Plastic Co., Hastings, Nebraska
Metalmold Forming Co., New York
●Microcell, Ltd., Low Dow, England
Pitman Plastic Products, Inc., Pitman, N. J.
Reinhardt Plastics Company, Denver, Colorado
South Salem Studios, South Salem, N. Y.
Springfield Cast Products, Inc., Springfield, Mass.

●Indicates Advertiser.

MOLD MAKERS, REINFORCED PLASTICS

Ace Plastic Molding Corp., L.I.C., N.Y.
Acme Plastic Products Co., Inc., Horsham, Pa.
Allied Mfg. Co., Seattle, Wash.
Atlas Plastics, Inc., Buffalo, N. Y.
●Blackhawk Molding Co., Inc., Addison, Ill.
Capitol Plastics Co., Inc., Lansing, Mich.
Chance, W. R., & Associates, Inc., Waldorf, Maryland
Chemtron Fiber Glass Co., El Monte, Calif.
Colt's Plastics Co., Inc., Hartford, Conn.
Cuming, M. A., & Co., Inc., New York
Damac Tool Co., Bronx, N. Y.
●Eagle Tool & Machine Co., Hillside, N. J.
Greene, Ray, & Co., Toledo, Ohio
Hanley Plastics Co., St. Louis, Mo.
Haveg Industries, Inc., Wilmington, Delaware
Herblin Corp., The, Glen Cove, N. Y.
Houghton Laboratories, Inc., Olean, N. Y.
Kellering, Victor, Inc., Brooklyn, N. Y.
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Keystone Plastic Eng. Co., Chicago
Lami-Plast Products Co., Tampa, Fla.
Mechtronics, Philadelphia, Pa.
●Microcell, Ltd., Low Dow, England
●Molded Products, Division of Admiral Corp., West Chicago
National Plastics, Inc., Knoxville, Tenn.
●Newark Die Company, Newark, N. J.
Oak Engineering Co., Inc., Gloucester City, N. J.
Pitman Plastic Products Inc., Pitman, N. J.
●Plasticrafters, Inc., Chicago
Plastic Suppliers & Manufacturers, Baton Rouge, La.
Ren Plastics, Inc., Lansing, Mich.
Reynolds Plastics, Inc., Walled Lake, Mich.
Schulz, Richard O. Company, Elmwood Park, Ill.
●Sierra Electric Corp., Gardena, Calif.
Springfield Cast Products, Inc., Springfield, Mass.
●Stricker-Brunhuber Corp., New York
Syracuse Plastic Molders, Syracuse, N. Y.
Timely Products Mfg. Co., Des Moines, Iowa
Una-Craft Engineering Co., Inc., Hazel Park, Mich.
United Die Molders, Inc., Chicago
United Mask & Nov. Co., Inc., Glendale, N. Y.
Wal-Mar Plastics, Inc., Torrance, Calif.
●Waterbury Companies, Inc., Waterbury, Conn.
Winner Mfg. Co., Inc., Trenton, N. J.
Zapf, Charles & Co., Evanston, Ill.
Zenith Plastics Co., Ypsilanti, Mich.

MOLD MAKERS, RUBBER

(See also Bags, Vacuum and Pressure under Supplies)

Ace Tool & Mfg. Co., Newark, N. J.
Akromold, Inc., Akron, Ohio
●Akron Presform Mold Co., Cuyahoga Falls, Ohio
Atkins & Merrill, Inc., Southbury, Mass.
Bricmar Manufacturing Corp., New York
Chemtron Fiber Glass Co., El Monte, Calif.
●Clifton Hydraulic Press Co., Clifton, N. J.
Colt's Plastics Co., Inc., Hartford, Conn.
●Custom Engineering Co., Erie, Pa.
Elastomer Chemical Corp., Newark, N. J.
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Pitman Plastic Products, Inc., Pitman, N. J.
Sarcol Foundry & Pattern Corp., Chicago
●Stricker-Brunhuber Corp., New York
Todaro, S. Co., Buffalo, N. Y.
U. S. Stoneware Co., Akron, Ohio

MOLD MAKERS, STEEL

ABA Tool & Die Co., Inc., Manchester, Conn.
A. G. P. Corporation, Peru, Ind.
A. S. K., Mfg. Co., Phila., Pa.
Ace Plastic Molding Corp., L.I.C., N.Y.
Ace Tool & Mfg. Co., Newark, N. J.
Acme Plastic Products Co., Inc., Horsham, Pa.
Akromold, Inc., Akron, Ohio
●Akron Presform Mold Co., Cuyahoga Falls, Ohio
Allied Engravers, Inc., New York
Allied Mfg., Co., Seattle, Wash.
Anderson Die & Mfg. Co., Portland, Oregon
●Anson Tools & Gages, Inc., Erie, Pa.
●Artag Plastics Corp., Chicago
Atlas Plastics, Inc., Little Ferry, N. J.
●Atols Tool & Mold Corp., Chicago
Baco Co., New York
Becker & van Hüllen, Krefeld
Beel Engineering Co., Newark, N. J.
Bergen Mold & Engineering Co., Little Ferry, N. J.
Bernard Plastics Molding Corp., Long Island City, N. Y.
●Blackhawk Molding Co., Inc., Addison, Ill.
Bondy Engineering Co., Brooklyn, N. Y.
Brilhart Plastics Corp., Mineola, N. Y.
Burlington Molding Corp., Burlington, N. C.
Buttondex Corp., New York
●Byrd Plastics, Inc., Erie, Pa.
Caco, Inc., Pomona, Calif.
Chaney Plastic Molding Co., Denver, Colorado
Chemtron Fiber Glass Co., El Monte, Calif.
●Chicago Mold Engineering Co., Inc., Hillside, Ill.
●Chili Plastics, Inc., N. Chili, N. Y.
●Clifton Hydraulic Press Co., Clifton, N. J.
●Cook, Lawrence H., Inc., East Providence, R. I.
Cowan Bowden Corp., Providence, R. I.
●Custom Engineering Co., Erie, Pa.
Damen Tool & Engineering Co., Chicago
●Danielson Manufacturing Co., Danielson, Conn.
●De Mattia Machine & Tool Co., Clifton, N. J.
●Die Molding Corp., Canastota, N. Y.
●Eagle Tool & Machine Co., Hillside, N. J.
Enduro Tool & Engineering Co., Chicago
●Engelking Patterns, Inc., Columbus, Ind.
●Falge Engineering Corp., Bethesda, Md.
●Federal Tool Corp., Chicago
Ferriot Bros., Inc., Akron, Ohio

Fortney Manufacturing Co., Inc., Newark, N. J.
Garray Plastics Co., Inc., Kearny, N. J.
Gary Enterprises, Inc., Brooklyn, N. Y.
Gibson Associates, Inc., Cranford, N. J.
Gifts Molding Corp., Chicago
Gulliksen, Wm. M., Mfg. Co., Hills, Mass.
•H. & R. Industries, Nazareth, Pa.
Hake Manufacturing Co., Inc., Roanoke, Va.
Hydro Molding Company, Inc., Plattsburgh, N. Y.
Industrial Eng. Service, South Easton, Mass.
Jalce Tool Co., Brooklyn, N. Y.
•Johnson Glass & Plastic Corp., Chicago
•Johnson Manufacturing Co., Chippewa Co., Chippewa Falls, Wisc.
Kellering, Victor, Inc., Brooklyn, N. Y.
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Kopplin Molding Corp., St. Louis, Mo.
Leominster Tool Co., Inc., Leominster, Mass.
•Liberty Tool & Machine Co., Irvington, N. J.
•Lor-El Company, Jersey City, N. J.
Many, J. & Co., New York
Maryland Plastics, Inc., Federalsburg, Md.
Metalmasters, Inc., Chicago
Micro Mold, Inc., Leominster, Mass.
•Midland Die & Engraving Co., Division of Prox Corp., Franklin Park, Ill.
Modern Molders, Inc., Kenilworth, N. J.
Modern Plastic Co., Los Angeles
Modern Tool & Die Co., Inc., Leominster, Mass.
Mojave Die & Engraving, Los Angeles
Moldcraft, Inc., Baltimore, Md.
•Molded Products, Division of Admiral Corp., West Chicago
Moldmakers, Incorporated, Peru, Indiana
Nalle Plastics, Inc., Austin, Texas
National Plastics, Inc., Knoxville, Tenn.
•Newark Die Company, Newark, N. J.
•Newark Die Hobbing & Casting Co., Newark, N. J.
Niles Corporation, South Bend, Indiana
Norco Plastic, Inc., Milwaukee, Wisc.
•Northwest Plastics, Inc., St. Paul, Minn.
Nu-Engineering, Inc., Ferndale, Mich.
Oak Engineering Co., Inc., Gloucester City, N. J.
Oakley Die & Mfg. Co., Cincinnati, Ohio
Omco Plastic Mold, Fremont, Indiana
Parker-Hartford Corp. The, Hartford, Conn.
•Paragon Molding Co., Melrose, Ill.
Paragon Plastic Corporation, New York
P. & H. Enterprises, New York
•Plasticrafters, Inc., Chicago
Plastics, Inc., St. Paul, Minn.
Plastic Mold & Die Co., Darby, Pa.
Plastic Mold Co., Maywood, Calif.
•Plura Plastics, Maplewood, N. J.
Poliner, William W., Englewood, N. J.
•Port Erie Plastics Corp., Erie, Pa.
•Precision Mold-Polishing, Roanoke, Va.
Primas Moldmakers, Inc., Buffalo, N. Y.
Process Mold Co., Detroit, Mich.
Randazzo Plastic Co., Los Angeles
Rayette, Inc., St. Paul, Minn.
Reinhardt Plastics Company, Denver, Colorado
Reinhold-Geiger Plastics, Inc., Los Angeles
Rochelle Plastic Mold Co., Inc., Clifton, N. J.
Roger Mfg. Co., Oakland, Calif.
Rosenthal, Alfred A., New York
Royal Mfg. Co., Inc., Prescott, Arizona
•Santay Corporation, Chicago
Sarcol Foundry & Pattern Corp., Chicago
Schaake Co., A. J., St. Paul, Minn.
Schulz, Richard O. Company, Elmwood Park, Ill.
Schwarzfaerber & Co., G. M. B. H. Nurmberg, Germany
•Sinko Mfg. & Tool Co., Chicago
Skyline Industries, Titusville, Pa.
Southeastern Plastics, Inc., Portsmouth, Va.
Southern Tool Manufacturing, Winston-Salem, N. C.
Sperzel Company, Minneapolis, Minn.
•Standard Tool Co., Leominster, Mass.
Sterling Plastics Co., Union, N. J.
Strabeg Machine Company, Bronx, N. Y.
•Stricker-Brunhuber Corp., New York
Sun Plastic, Inc., Cuyahoga Falls, Ohio
•Superior Plastics, Inc., Chicago
Syracuse Plastic Molders, Syracuse, N. Y.
Tech-Art Plastics Co., Morristown, N. J.
•Tilp, V. G, Inc., Union, N. J.
Todaro, S. Co., Buffalo, N. Y.
Una-Craft Engineering Co., Inc., Hazel Park, Mich.
United States Plastic Molding Corp., Wallingford, Conn.
United Tool Company, Bridgeport, Conn.
•Van Dorn Iron Works Co., Cleveland, Ohio
Varney, Incorporated, Miami, Fla.
Voges Manufacturing Co., Inc., Ozone Park, N. Y.
W & A Co., Inc., Attleboro, Mass.
•Waterbury Companies, Inc., Waterbury Conn.
Wilpey Tool & Mfg. Co., Kearny, N. J.
Zaph, Charles & Co., Evanston, Ill.

MOLD POLISHING

•Acme Scientific Co., Chicago
•Akron Presform Mold Co., Cuyahoga Falls, Ohio
Bondy Engineering Co., Brooklyn, N.Y.
Damac Tool Co., Bronx, N.Y.
Damen Tool & Engineering Co., Chicago
Hake Manufacturing Co., Inc., Roanoke, Va.
Industrial Eng. Service, South Easton, Mass.
•Micron Specialties Co., Chicago
Moldcraft, Inc., Baltimore, Md.
Mold Polishing Service, Riverdale, N.J.
•Newark Die Co., Newark, N. J.
•Nutmeg Chrome Corp., West Hartford, Conn.
Paragon Plastic Corporation, New York
•Precision Mold & Polishing, Roanoke, Va.
Rochelle Plastic Mold Co., Inc., Clifton, N.J.
Springfield Cast Products, Inc., Springfield, Mass.
Una-Craft Engineering Co., Inc., Hazel Park, Mich.
Vapor Blast Mfg. Co., Milwaukee, Wisc.
•Zapf, Charles, & Co., Evanston, Ill.

PERFORATING PLASTIC SHEETING

American Hard Rubber Co., New York
Blacher, B., New York
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada
•Carroll, J. B., & Co., Chicago
Chicago Price Tag Mfg. Co., Chicago
Crystalx Corp., Lenni Mills, Pa.
•Emeloid Co., Inc., Hillside, N.J.
Kendall, The Co., Chicago
•Microcell, Ltd., Low Dow, England
•Perforating Industries, Inc., Roselle Park, N.J.
•Perforating Specialties, New York
Staff Die Cutting Co., New York
Westlake Plastics Company, Lenni Mills, Pa.

PLATING MOLDS, RAMS AND PLATES

(Hard Chromium)

•Akron Presform Mold Co., Cuyahoga Falls, Ohio
•Chromium Corp. of America, New York
Damen Tool & Engineering Co., Chicago
Diamond Hard Chromium Co., Newark, N.J.
Har-Conn Chrome Co., West Hartford, Conn.
Industrial Eng. Service, South Easton, Mass.
•Micron Specialties Co., Chicago
•Nutmeg Chrome Corp., West Hartford, Conn.
Omco Plastic Mold, Fremont, Indiana
•Plating Eng. Co., Milwaukee, Wisc.
Southern Toll Mfg. Co., Winston, N. C.
Una-Craft Engineering Co., Inc., Hazel Park, Mich.

POSTFORMING

(of Laminates)

Aacon Industries, Inc., Brooklyn, N.Y.
Atlas Plastics, Inc., Buffalo, N.Y.
Blackman Plastics, Culver City, Calif.
•Cadillac Plastic & Chemical Co., Detroit, Mich.
•Carroll, J. B., & Co., Chicago
Chemtron Fiber Glass, El Monte, Calif.
•Continental-Diamond Fibre Corp., Newark, Del.
Crowl, Charles, Co., El Monte, Calif.
Curry Arts Molding & Laminating Co., Scranton, Pa.
•Emeloid Co., Inc., Hillside, N.J.
Emerson Plastics Corp., Bronx, N.Y.
Engineered Plastics, Inc., Gibson, N.C.
•Faige Engineering Corp., Bethesda, Md.
General Plastics Mfg. Co., Tacoma, Wash.
Gladwin Plastics, Inc., Atlanta, Ga.
Industrial Plastic Supply Div., W. Hartford, Conn.
Insulating Fabricators of New England, Inc., Watertown, Mass.
Lee, Walter Chemical Corp., Bronx, N.Y.
Long, Thomas J. Inc., New York
Murray Plastics Company, Poughkeepsie, N.Y.
•National Vulcanized Fibre Co., Wilmington, Del.
Northern Plastics Corp., La Crosse, Wisc.
Paragon Plastic Corp., New York
Pine-Wood Plastic Co., Inc., Cambridge, Mass.
Plastic Age Sales, Inc., San Fernando, Calif.
Plastics, Laminates & Fabrics, Inc., Chicago
Regal Plastic Co., Kansas City, Mo.
Reynolds Plastics, Inc., Walled Lake, Mich.
Silicone Insulation, Inc., Bronx, N.Y.
•Swedlow Plastics Co., Los Angeles

•Indicates Advertiser.

Synthane Corp., Oaks, Pa.
U.S. Plastic Molding Corp., Wallingford, Conn.
Westinghouse Electric Corp., Micarta Division, Hampton, S.C.
Zenith Plastics Co., Ypsilanti, Mich.

PRINTING

A. Flexible plastic film and sheeting
B. Rigid Plastic sheets
C. Finished plastic products (toys, bottles, novelties, etc.)

A & B Plastics, Seattle, Wash. (*B*)
Aacon Industries, Inc., Brooklyn, N.Y. (*A, B, C*)
Accurate Gold Stamping Co., Inc., New York (*A, B, C*)
Acme Laminating & Plastics Co., Detroit, Mich. (*A, B, C*)
● Acromark Co., Elizabeth, N.J. (*C*)
Allegheny Plastics, Inc., Coraopolis, Pa. (*B*)
Allied Engraving & Stamping Co., Buffalo, N.Y. (*A, B, C*)
American Combining Corp., Rockaway Beach, Queens, N.Y. (*A*)
Ameriplastic Co., Flint, Mich. (*B, C*)
● Amos Packaging Co., Edinburg, Ind.
Art Decorating Co., North Bergen, N.J. (*B, C*)
Art Plastic Mfg. Co., Los Angeles, Calif. (*A, B, C*)
Atlas Plastic Specialties, Inc., Chicago (*B*)
● Barron, J. E., Plastics, Inc., Cincinnati, Ohio (*A, B, C*)
Bernard Plastics Molding Corp., Long Island City, N.Y. (*C*)
Blossom Mfg., Co., New York
● Bolta Products Div., General Tire & Rubber Co., Lawrence, Mass. (*A, B*)
Borkland Mfg. Co., Marion, Ind. (*B, C*)
Brutier Products Co., Inc., Secaucus, N.J. (*A*)
Canadian Resins & Chemicals, Ltd., Montreal, Quebec, Canada (*A*)
Canton Containers, Canton, Ohio (*A*)
Carolina Plastics Co., Charlotte, N.C. (*B, C*)
● Carroll, J. B., & Co., Chicago (*B*)
Celluplastic Corp., Newark, N.J. (*C*)
Chaney Plastic Molding Co., Denver, Colorado (*C*)
Chelsea Mills, Div. of Novelty BB-Co., New York (*A, B*)
Chicago Price Tag Mfg. Co., Chicago (*B, C*)
● Coating Products, Englewood, N.J. (*A*)
Continental Can Co., Inc., Mt. Vernon, Ohio (*A*)
● Cosom Engineering Corp., Mpls., Minn. (*C*)
Crystalx Corp., Lenni Mills, Pa. (*A*)
Darnell Manufacturing Co., Orange, Va. (*C*)
Denver Plastics, Inc., Golden, Col. (*B*)
Dura-Lee Corp., Kansas City, Miss. (*A*)
Einson-Freeman Co., Long Island, N.Y. (*A, C*)
● Emaloid Co., Inc., Hillside, N. J. (*B, C*)
Entwistle Manufacturing Corp., Providence, R. I. (*A, B, C*)
Equitable Paper Co., Inc., Long Island City, N. Y. (*A, C*)
● Falge Engineering Corp., Bethesda, Md. (*B*)
Farrington Texol Corp., Walpole, Mass. (*A*)
Fawn Plastics Co., Inc., Baltimore, Md. (*C*)
Felsenthal, G., & Sons, Chicago (*A, B*)
● General Tire & Rubber Co., Akron, Ohio (*A*)
● General Tire & Rubber Co., Marion, Ind. (*B*)
Gits Molding Corp., Chicago (*C*)
Glassoloid Corp. of America, Clifton, N. J. (*B*)
Goodren Products Corp., Englewood, N. J. (*A*)
Gorden-Lacey Chemical Products Co., Inc., Maspeth, N. Y. (*A*)
● Hopp Plastics, New York (*A, B*)
Ideal Gold Stamp Co., New York (*A, B, C*)
Industrial Plastic Supply Div., W. Hartford, Conn. (*C*)
Industrial Sales Engineers, New York (*A, B, C*)
Insulating Fabricators of New England, Inc., Watertown, Mass. (*B*)
Jupiter Plastics, Inc., Pittsfield, Mass. (*B*)
Kehr Products Company, Philadelphia, Pa. (*A*)
Leathertone, Inc., Boston, Mass. (*B*)
Malco Plastics, Inc., Baltimore, Md. (*B*)
Mankato Paper Box Co., Mankato, Minn. (*B*)
Marbek Inc., Brooklyn, N. Y. (*A*)
Motson, J. Frank Co., Flourtown, Penna. (*B, C*)
Milprint, Inc., Milwaukee, Wisc. (*A*)
Mitchell Plastics, Inc., Owosso, Mich. (*C*)
Name Plate Products Co., Philadelphia, Pa. (*A, B, C*)
Nas-Kay Industries, Philadelphia, Pa. (*B*)
Newark Paraffine & Parchment Paper Co., Newark, N. J. (*A*)
Newcraft Mfg. Corp., Long Island City, N. Y. (*C*)
Norco Plastic Inc., Milwaukee, Wisc. (*C*)
Paragon Plastic Corporation, New York (*B, C*)
Plast-Ad Mfg. Co., South Bend, Ind. (*A, B*)
Plas-Ties Company, Santa Ana, Calif. (*A*)
Permanent Label Corp., Bloomfield, N. J. (*B, C*)
Plastic Film Corp., Plainfield, Conn. (*A*)
Plastic Inlays Corp., Summit, N. J. (*C*)
Plastic Innovations, Inc., Yonkers, N.Y. (*A, B*)
Plastics, Laminates & Fabrics, Inc., Chicago (*B, C*)
● Plaxall, Inc., Long Island City, N. Y. (*B, C*)
● Plura Plastics, Maplewood, N. J. (*C*)
Poly Plastic Products, Inc., Paterson, N. J. (*A*)
Premier Plastics Co., Milwaukee, Wisc. (*B, C*)
Printloid Plastics, Inc., New York (*B*)
Presco Plastics, Milwaukee, Wisc. (*B*)
Ridge Printing Co., Inc., Ridgefield, N. J. (*A*)
Romar Plastics, Inc., St. Charles, Ill. (*C*)
Rondale Company, Inc., The, Roselle, N. J. (*A*)
Royal Mfg. Co., Inc., Prescott, Arizona, (*C*)
Rudd Plastic Fabrics, Corp., Brooklyn, N. Y. (*A*)
Sealview Plastics, Inc., Wayne, Pa. (*B*)
Shaw-Randall Co., Inc., Pawtucket, R. I. (*B*)
Shoe Form Co., Inc., Auburn, N. Y. (*B, C*)
Shore Line Industries, Clinton, Conn. (*A*)
● Sillcocks-Miller Co., The, Maplewood, N. J. (*A*)
● Sinko Mfg. & Tool Co., Chicago (*C*)
Sommers Plastic Prod. Co., New York (*A*)
Sorg Paper Company, The, Middletown, Ohio (*A*)
Sperzel Co., Minneapolis, Minn. (*C*)
Stensgaard W. L. and Associates, Inc., Chicago (*A, B*)
● Superior Plastics, Inc., Chicago (*B, C*)
Synthane Corp., Oaks, Pa. (*B*)
Syracuse Plastic Molders, Syracuse, N. Y. (*B, C*)
Therm-O-Form Plastics Co., Homewood, Ill. (*A, B*)
Timely Products Mfg., Co., Des Moines, Iowa (*B, C*)
Topflight Corp., York, Pa. (*A*)
Tri-State Plastic Molding Company, Henderson, Ky. (*C*)
● United Laminations, Inc., Mayfield, Pa. (*A, B*)
United Mask & Nov. Co., Inc., Glendale, N. Y. (*B*)
Varney, Incorporated, Miami, Fla. (*C*)
Velveray Corporation, New York (*A*)
Virginia Plak Company, New York (*B*)
W & A Co., Inc., Attleboro, Mass. (*C*)
Wellington Print Works, Inc., Trenton, N. J. (*A*)
Wessel, Stanley & Company, Chicago(*B*)
Willson Camera Co., Inc., Havertown, Pa. (*B*)

PULVERIZING

Amco Plastic Materials, Inc., Brooklyn, N.Y.
● American Molding Powder & Chemical Corp., Brooklyn, N.Y.
American Pulverizer Co., St. Louis, Mo.
Bamberger, Claude P., Inc., Ridgefield Park, N.J.
Blane Corp., Canton, Mass.
Blum, Paul, Co., Buffalo, N.Y.
Collins, Caldwell & Dague, Paramount, Calif.
Danberg Chemical Co., Wallingford, Conn.
● Holland, M., Co., Chicago, Ill.
Oppenheimer Corp., Buffalo, N.Y.
Schutz-O'Neill Company, Minneapolis, Minn.

RECLAIMERS, PLASTIC MATERIALS

Alpha Chemical & Plastics Corp., Newark, N. J.
Amco Plastic Materials, Inc., Brooklyn, N. Y.
● American Molding, Powder & Chemical Corp., Brooklyn, N. Y.
American Pyroxlin Corp., Arlington, N. J.
Bamberger, Claude P., Inc., Ridgefield Park, N. J.
Blane Corp., Canton, Mass.
Blum, Paul, Co., Buffalo, N. Y.
Collins, Caldwell & Dague, Paramount, Calif.
Duke Plastics Corp., Brooklyn, N. Y.
Elton, Ted, North White Planes, N. Y.
● Erie Plastics Co., Inc., Erie, Pa.
● Gering Products, Inc., Kenilworth, N. J.
● Holland, M., Co., Chicago, Ill.

● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

●Interplastics Corp., New York
Marine Plastics, Inc., Clinton, Mass.
Multiplastics, Inc., Wallingford, Conn.
●Muehlstein, H., & Co., Inc., New York
Nebraska Plastics, Inc., Cozad, Nebraska
Oppenheimer Corp., Buffalo, N. Y.
Plandex Corporation, Downingtown, Pa.
Plastic Materials, Inc., Hicksville, N.Y.
●Plastic Molders Supply Co., Inc., Fanwood, N. J.
●Plastic Molding Powders, Inc., Brooklyn, N. Y.
●Shulman, A., Inc., Akron, Ohio
Shuman, Philip & Sons, Buffalo, N. Y.
●Superior Plastics, Inc., Chicago
U. S. Plastic Products Corp., Metuchen, N. J.
Western Plastic & Rubber Co., Richmond, Calif.
●Woloch, George, Co., Inc., New York
Zenner, Justin, Chicago

RESIN PULP AND FIBRE PROCESSORS

●Plymouth Fibres, Inc., Brooklyn, N. Y.

ROTATIONAL CASTING, SEE SLUSH MOLDING

SILK SCREEN MAKERS

Aacon Industries, Inc., Brooklyn, N. Y.
Briemar Manufacturing Corp., New York
Chelsea Mills, Div. of Novelty BB-Co., New York
●Como Plastic, Inc., Columbus, Indiana
Crystalx Corp., Lenni Mills, Pa.
Dec-Art Process Co., Inc., New York
Dura Plastics of New York, New York
Ideal Gold Stamp Co., New York
International Plastic, New York
Kerr, R. W. Plastic Co., Hastings, Nebraska
Kerrco Products, Lincoln, Nebraska
Lustro-Cite Industries, Inc., Brooklyn, N. Y.
Midwest Decalcomania Co., Chicago
Milprint, Inc., Milwaukee, Wisc.
Nas-Kay Industries, Philadelphia, Pa.
Paragon Plastic Corporation, New York
Plast-Ad Mfg. Co., South Bend, Indiana
Pioneer Valley Plastics Co., Chicopee, Mass.
Permanent Label Corp., Bloomfield, N. J.
Premier Plastics Co., Milwaukee, Wisc.
Royal Mfg. Co., Inc., Prescott, Arizona
South Salem Studios, South Salem, N. Y.
Southeastern Sales Corp., St. Petersburg, Fla.
Stensgaard, W. L., and Associates, Chicago
●Superior Plastics, Inc., Chicago
Ulano Products Company, Brooklyn, N. Y.
United Mask & Nov. Co., Inc., Glendale, N. Y.
Vavrik-Industrial Design, Louis, Rossford, Ohio

SLITTING, CUTTING, SHEETING, PLASTIC FILM

Aacon Industries, Inc., Brooklyn, N. Y.
Acme Laminating & Plastics Co., Detroit, Mich.
●Barron, J. E., Plastics Co., Cincinnati, Ohio
Blacher, B., New York
Brutier Products Co., Inc., Secaucus, N. J.
●Cadillac Plastic & Chemical Co., Detroit, Mich.
Canton Containers, Inc., Canton, Ohio
●Coating Products, Englewood, N. J.
Crook, William A., Co., Inc., Watertown, Mass.
Crystalx Corp., Lenni Mills, Pa.
●Danielson Manufacturing Co., Danielson, Conn.
●Davis, Joseph Plastics Co., Arlington, N. J.
Dura-Lee Corp., Kansas City, Miss.
●Fabrico Mfg. Corp., Chicago
Forbes Products Corp., Rochester, N. Y.
Gomar Manufacturing Co., Inc., Linden, N. J.
●H. & R. Industries, Nazareth, Pa.
Industrial Sales Engineers, New York
Kehr Products Company, Philadelphia, Pa.
●Liberty Cutting Die Co., New York
Malco Plastics, Inc., Baltimore, Md.
●Muehlstein, H., Co., Inc., New York
Newark Paraffine & Parchment Paper Co., Newark, N. J.
Plastic Laminating Corp., Vaux Hall, N. J.
●Plastics, Laminates & Fabrics, Inc., Chicago
Protective Lining Corp., Brooklyn, N. Y.
Rudd Plastic Fabrics Corp., Brooklyn, N. Y.
Ruf Machine Co., Inc., New York
●Sandman, Eli Co., Worcester, Mass.
Shoe Form Co., Inc., Auburn, N. Y.
Springfield Fabricators, Inc., Springfield, N. J. (*Cutting*)
●Transilwrap Company, Chicago
Westlake Plastics Company, Lenni Mills, Pa.

SLUSH MOLDING AND ROTATIONAL CASTING

Aacon Industries, Inc., Brooklyn, N. Y.
●Akron Preform Mold Co., Coyahoga Falls, Ohio
Atlas Plastics, Inc., Buffalo, N. Y.
Blue Ribbon Shoe & Novelty Co., Inc., Bklyn, N. Y.
Briemar Manufacturing Corp., New York
Fiberoid Doll Products Corp., Bronx, N. Y.
Flexible Products Co., Marietta, Ga.
Haveg Industries, Inc., Wilmington, Delaware
Industrial Sales Engineers, New York
International Plastic, New York
Kerrco Products, Lincoln, Nebraska
Kusan Incorporated, Nashville, Tenn.
L. & P. Tool Company, Cincinnati, Ohio
Plastic Rotocast Co., Chicago
Polykote, Inc., Cleveland, Ohio
Regal Plastic Co., Kansas City, Mo.
Reinhardt Plastics Company, Denver, Colorado
Sarcol Foundry & Pattern Corp., Chicago

SPRAY MASKS

Akron Preform Mold Co., Cuyahoga Falls, Ohio
Arnkurt Associates Engineers, New York
Clear View Plastics Corp., Poplar Bluff, Miss.
●Conforming Matrix Corp., Toledo, Ohio
●Flore, William M., Inc., Brooklyn, N. Y.
●Finish Engineering Co., Erie, Pa.
Houghton Laboratories, Inc., Olean, N.Y.
●Jay Company, T. V., Chicago
Kaye Plastics Corporation, New Brunswick, N. J.
Matthews, Jas. W. &Co., Pitts., Pa.
●Molded Products, Division of Admiral Corp., West Chicago
Paragon Plastic Corporation, New York
Planet Plating Co., Inc., Brooklyn, N. Y.
Premier Plastics Co., Milwaukee, Wisc.
Reinhardt Plastics Company, Denver, Colorado
Ren Plastics, Inc., Lansing, Mich.
Servwell Products Co., The, Cleveland, Ohio
Staff Die Cutting, Co., New York
●Thierica Studio, Inc., Grand Rapids, Mich.
Timely Products Mfg. Co., Des Moines, Iowa
Topflight, Corp., York, Pa.
W & A Co. Inc., Attleboro, Mass.

TESTING LABORATORIES

Akron Preform Mold Co., Cuyahoga Falls, Ohio
Aries, R. S. & Associates, New York
Chemical Research, Upper Carby, Pa.
Colburn Laboratories, Inc., Chicago
Colt's Plastics Co., Inc., Hartford, Conn.
●DeBell & Richardson, Inc., Hazardville, Conn.
●Desert Sunshine Exposure Tests, Phoenix, Arizona
●Fostoria Pressed Steel Corp., Fostoria, Ohio
Froehling & Robertson, Inc., Richmond, Va.
●Furane Plastics, Inc., Los Angeles, Calif.
Gayness Engineering Co., Chicago
Greene, Ray, & Co., Toledo, Ohio
Hanley Plastics Co., St. Louis, Mo.
●Lupoline Automatic, Tuckahoe, N. Y.
McMillan Industrial Corp., Ipswich, Mass.
●Microcell, Ltd., Low Dow, England
●Muehlstein, H., Co., Inc., New York
Naken, William, Los Angeles
New England Laboratories, Ipswich, Mass.
Northeastern Plastics, Inc., Boston, Mass.
Patzig Testing Laboratories, Des Moines, Iowa
Radiation Applications Incorporated, New York
Ren Plastics, Inc., Lansing, Mich.
Resin Research-Laboratories, Newark, N. J.
Rhodes, Philip H., Cincinnati, Ohio
Rudd Plastic Fabrics, Brooklyn, N. Y.
Skeist Laboratories, Newark, N. J.
Snell, Foster D., Inc., New York
●South Florida Test Service, Miami, Fla.
Stringfield, Raymond B., Los Angeles
United States Testing Co., Hoboken, N. J.

●Indicates Advertiser.

CONVERTERS AND PROCESSORS

The following personnel and equipment directories are designed to be as complete as possible on the basis of available information submitted by the companies themselves. Listings are alphabetical and geographical, by state.

CUSTOM MOLDERS AND EXTRUDERS

C—Compression; E—Extrusion; I—Injection; T—Transfer; CM—Cold Molding

ALABAMA

Decatur Plastic & Eng., Inc., Decatur (*I*)
Injection Machines: 4-3 oz.; 1-12 oz.; 1-16 oz.
Pres., Sls. Mgr. & Pur. Agt.—M. E. Hickson
Vice Pres.—John Sewell

ARIZONA

***Royal Mfg. Co., Inc.,** Prescott, (*I, E*)
Injection Machines: 1-4 oz.; 1-6 oz.; 3-8 oz.
Extrusion Machines: 1-2½"; 7-3½"; 2-4½"
Pres. & Sales Mgr.—C. C. Coates
V. Pres.—John D. Jackson & H. L. Berman
Pur. Agt.—E. C. Sturm

CALIFORNIA

***Alladin Plastics, Inc.,** Los Angeles (*I*)
Injection Machines: 8 oz.-4; 16 oz., 1; 12-16 oz., -1; 20-28 oz.-3; 2-3 oz.-1
Pres.—Sam Avedon
Vice Pres.—Hon. L. Taylor, Plant Supt.
Sales Mgr.—Nelson Trust
Pur. Agt.—Fred R. Berman

***American Molding Co.,** San Leandro ((*C, I, T, E*)
Compression Presses: 8
Injection Machines: 6 to 12 oz.
Transfer Presses: 3 to 150 tons
Extrusion Machines: 3 to 3½"
Pres.—W. D. Love, Jr.
Chief Eng.—John Robb
Sales Manager—Harry Peet
Pur. Agt.—E. B. Mellor

Art Plastics Mfg. Co., Los Angeles (*C, I, E*)
Compression Presses: 3
Injection Machines: 3
Pres.—R. R. Conell
Vice Pres.—Henry Conell
Sales Mgr.—Frank Brown

Automatic Plastic Molding Co., Berkeley (*C, T*)
Compression Presses: 1-15 ton; 1-150 ton; 1-250 ton
Injection Machines: 2-4-6; 2-8
Pres.—Forrest Engelhart
Vice Pres.—A. J. Carlson
Sales Mgr.—A. J. Carlson
Pur. Agt.—Forrest Barnes

***Chemtron Fiber Glass Co.,** El Monte (*CM*)
Pres.—R. L. Kinch
Vice Pres.—C. L. Kuchinsky
Sales Mgr.—J. C. Larcom
Pur. Agt.—A. R. Kinsley

***Collins, Caldwell & Dague, Paramount** (*E*)
Extrusion Machines: 4
Pres.—Wm. B. Collins
Vice Pres.—Lee M. Caldwell
Sales Mgr.—Harold F. Dague

Crest Molded Products, Inc., Arcadia (*C, T*)
Compression Presses: 2-40 ton; 6-150 ton; 2-200 ton; 2-300 ton
Transfer Presses: 2-40 ton; 2-80 ton; 4-150 ton, 2-200 ton
Pres.—Charles Marins
Vice Pres.—Stephen Civerolo
Sales Mgr. & Pur. Agt.—K. R. Mergen

Delkay Plastics Corp., Inglewood (*I*)
Injection Machines: 1-3 oz.; 3-6 oz.; 3-16 oz.
Owners: Edmond Favre & Jack Mersman

***Eldon Manufacturing Co.,** (*C, T*)
Compression Presses: 18-50 ton to 350 ton
Transfer Presses: 14-50 to 200 ton
Pres.—Robert Silverstein
Vice Pres.—Walter Burroughs
Sales Mgr & Gen. Mgr.—Darrel Francy
Pur. Agt.—Louis Berkowitz

***Gaylord Plastics, Inc.,** Santa Monica (*C, T*)
Compression Presses: 1-10 ton; 1-75 ton; 4-85 ton
Transfer Presses: 1-2 ton; 5-10 ton
Pres. & Sales Mgr.—G. W. Main
Vice Pres. & Pur. Agr.—H. P. Grimberg

***Gibbs Manufacturing Co.,** Berkeley (*C, I*)
Compression Presses: 10-30 to 300 tons
Injection Machines: 1-6 oz.; 1-12 oz.
Pres.—J. Gibbs

***Jet Specialties Co., Inc.,** Los Angeles (*I, E*)
Injection Machines: 6 oz.; 8 oz.; 16 oz.; 2 oz.
Extrusion Machines: 5-2½"; 1-1½"; 1-2"; 2-3½"
Pres. & Gen. Mgr.—Lloyd W. Johnson
Vice Pres. & Sales Mgr.—Gerald H. Johnson
Controller, Pur. Agt., & Ass't to Pres.—Malcolm S. Haywood

Kennerley-Spratling, Inc., Berkeley (*C, I, T*)
Compression Presses: 50 to 100 ton
Injection Machines: 3 to 16 oz.
Transfer Presses: 50 to 100 ton
Pres.—Fred L. Kennerley
Vice Pres.—J. H. Murphy
Secy. & Vice Pres.—Ernest N. Spratling
Treas.—R. W. Garrett

***Kralov Plastic Pipe Co., Inc.,** Los Angeles (*E*)
Extrusion Machines: 2-2½"; 1-3½"; 1-4½"
Pres.—Arthur Gow
Vice Pres.—Robert C. Raab
Sales Mgr.—Russell W. Johnson
Pur. Agt.—B. Priess

***Lynch Asbestos Co.,** Los Angeles (*E*)
Extrusion Machines: 2-(1-2½ & 1-4½)
Pres.—R. O. Lynch
Vice Pres.—J. C. Hontev
Pur. Agt.—C. Cruen

***Marken Plastic Corp.,** Los Anglees (*E*)
Extrusion Machines: 2-3½"; 1-2½"
Pres.—Andrew M. Martin
Vice Pres. & Gen. Mgr.—W. Aidney Aitken
Vice Pres. & Plant Supt.—Ralph Luck

***Modern Plastics Co.,** Los Angeles (*I*)
Injection Machines: 1-4 oz.; 1-8 oz.; 2-8 oz.; 1-12 oz., 3-16 oz.
Pres.—George W. Van Vorst
Vice Pres.—Kenneth F. Carraher
Sales Mgr. & Gen. Mgr.—Myron W. Plum
Pur. Agt.—Ethel S. Wilson

Monrovia Plastic Co., Inc., Monrovia (*I*)
Injection Machines: 2-12 oz.; 1-4 oz.
Pres.—Swanson
Vice Pres.—Adsen Melickian
Gen. Mgr. & Secy.—W. R. Swanson

***New Plastic Corp.,** Los Angeles (*I*)
Injection Machines: 5-16 oz.

***Olympic Plastics Co., Inc.,** Los Angeles (*C, I, T*)
Compression Presses: 12-75-300 tons
Injection Machines: 8-2 oz.-16 oz.
Transfer Presses: 4-50-250 tons
Pres.—David Rome
Vice Pres.—David C. Siteman
Sec., Treas. & Pur. Agt.—Harry Scott

***Peat Manufacturing Co.,** Norwalk (*I*)
Injection Machines: 1-16 oz.; 1-12 oz.; 3-8 oz.
Pres.—Roy L. Peat
Sales Mgr. & Pur. Agt.—C. O. Menig

* Operates own tool room.
● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

*Plastic Age Sales, Inc., San Fernando (C, T)
Compression Presses: 1-450 ton, 48 x 80-48"; 1-110 ton, 14 x 120; 1-75 ton, 36 x 48; 10-12 x 24-48, 35 tons; 3-12 12-48", 35 ton; 1-36-48-45 ton.
Transfer Presses: 1-12 x 12-75 ton, 1-12 x 24-75 ton
Pres.—J. A. Dramer
Sales Mgr.—H. E. Renner
Pur. Agt.—Adolph Kramer

*Plastic Process Company, Division of Monadnock Mills, Los Angeles (E)
Extrusion Machines: 7-2½" to 4½"
Pres.—E. E. Kotkin
Vice Pres.—H. H. Wenk & H. R. Hedstron
Pur. Agt.—Mark Kotkin

Plastron Specialties, Inc., Los Angeles, (E)
Extrusion Machines: 1-1"; 2-2½"; 1-3½"

*Randazzo Plastic Co., Los Angeles (I)
Injection Machines: 5-3-8 oz.: One-4 oz.; One-12 oz.
Partner: Marco G. Randazzo
Partner: Marion G. Randazzo
Partner: Gus Rizzo

*Reinhold Engineering & Plastics Co., Norwalk (C, I, T)
Compression Presses: 8-100 ton, 4-200 ton; 2-250 ton; 2-300 ton; 3-400 ton; 2-750 ton
Injection Machines: 3-4 oz.
Transfer Presses: 3
Pres.—James P. Gruettner
V. Pres. Administration—H. J. Harris
Sales Mgr.—William H. Barner
Pur. Agt.—H. J. Harris

*Reinhold-Geiger Plastics, Inc., Los Angeles, (C, I, T)
Compression Presses: 39-100 to 4000 ton
Injection Machines: 7-1 to 3 oz.
Transfer Presses: 11-100 ton
Pres.—Lisle Reinhold
V. Pres.—Harry Geiger
Manager—Edgar A. Wanczuk

*Resinite Department, The Borden Co., Santa Barbara (E)
Extrusion Machines: 10 machines, various sizes
Gen. Mgr.—Grant Erlich
Sales Mgr. Industrial Production—Howard G. Smith
Sales Mgr. Consumer Goods—William Sedar

*Revell Industrial Division, Venice (I)
Injection Machines: 15-2 oz. to 12 oz.
Pres.—Lewis H. Glaser
Sales Engineer—Bernard Diggins
Pur. Agt.—Oliver Kimball

*Roger Mfg. Co., Oakland (C, I)
Compression Presses: 1-30 ton; 1-40 ton; 1-75 ton
Injection Machines: 1-4 oz.; 1-8 oz.; 1-16 oz.
Pres. and Owner—A. J. Roger

● Sierra Electric Corp., Gardena (C, I, T)
Compression Presses: 45-100 to 600 ton
Injection Machines: 2-4 to 8 oz.
Transfer Presses: 20-50 to 500 ton
Pres. & Sales Mgr.—L. T. Bordner
V. Pres.—R. R. Turner
Pur. Agt.—Lon Landry

*Westland Plastics, Inc., Los Angeles (I)
Injection Machines: 1-2 oz.; 1-9 oz.; 4-12 oz.; 1-16 oz.
Pres.—Fred Forsman
V. Pres.—Russel Forsman
Sales Mgr.—Bert Murman
Pur Agt.—Gus Forsman

*Wilcox Plastics, Inc., Montebello (C, I, T)
Compression Presses: 15-50 to 300 ton; 8-15 to 40 ton
Injection Machines: 3-6 oz.
Transfer Presses: 7-50 to 200 ton
Pres.—Frank Wilcox
V. Pres.—Chas. L. Nichols
Sales Mgr. B. H. Enos
Pur. Agt.—E. N. Huling

*Windman Brothers, Los Angeles (C, I)
Compression Presses: 20-75-400 ton
Injection Machines: 12-4 oz.-12 oz.
Pres.—Philip Windman (Partner)
V. Pres.—Sam & Murray Windman (Partner)
Sales Mgr.—Irving Windman (Partner)
Pur. Agt.—Oscar Windman (Partner)
Pur. Agt.—Fred Windman (Partner)

COLORADO

*Chaney Plastic Molding Co., Denver (I)
Injection Machines: 2-9 oz.; 2-6 oz.; 1-2 oz.
Pres., Sales Mgr. & Pur. Agt.—J. E. Chaney

*Denver Plastics, Inc., Golden (C, I)
Compression Presses: 1
Injection Machines: 4
Pres.—R. L. Millard
Sales Mgr.—H. F. Kusserow
Pur. Agt.—C. A. Gates

Ingwesen Manufacturing Co., Inc., Denver (I)
Injection Machines: 1-4 oz.; 2-8 oz.; 1-16 oz.
Pres. Sales Mgr.—T. E. Taplin
Vice Pres. & Pur. Agt.—M. B. Hecox

*Pikes Peak Plastics, Inc., Colorado Springs (C, I)
Compression Presses: 2-20 ton
Injection Machines: 2-1-4 oz.; 1-1 oz.
Pres.—Egon W. G. Wieselmann
Vice Pres.—Florence E. Wieselmann

*Reinhardt Plastics Company, Denver (C, I, T)
Compression Presses: 2-35T; 1-125 ton
Injection Machines: 1-1 oz.; 2-2 oz.; 1-4 oz.
Transfer Presses: 1-35T

*V. F. Rogers Plastic Molding, Denver (C, I, T)
Compression Presses: Three-18 ton, One 50 ton
Injection Machines: One 1 oz.
Transfer Presses: One-50 ton
Owner: V. F. Rogers

Yorker and Sons, Inc., Denver (I)
Injection Machines: 1-12 oz.; 1-8 oz.; 1-4 oz.; 2-2 oz.
Pres. & Pur. Agt.—Oscar B. Yorker
V. Pres.—Scott A. Gale
Gen. Mgr. & Sales Mgr.—Jack R. Peckman

CONNECTICUT

Atlantic Plastics, Inc., Stanford (I)
Injection Machines: 6-12 oz.; 2-4 oz.; 4-2 oz.
Pres.—Joseph E. Benoit
Vice Pres.—Neil S. Waterman
Treas.—William F. Sanford

●Bridgeport Molded Products, Inc., Fairfield, Conn. (C, I)
Compression Presses: 452 ton; 13-150 ton; 10-100 ton; 31-50 ton; 3-15 ton; 1-314 ton; 5-300 ton; 4-200 ton.
Injection Machines: 1-200 oz.; 1-28 oz.; 6-8 oz.; 1-60 oz.; 2-16 oz.; 2-6 oz.; 1-48 oz.; 1-22 oz.; 3-4 oz.; 1-32 oz.; 6-12 oz.; 3-2 oz.
Pres. & Sales Mgr.—L. P. Clark
Vice Pres.—E. A. Tyler
Pur. Agt.—E. Dattalo

Bridgeport Plastics & Rubber Co., Inc., Bridgeport (I)
Injection Machines: 2 1-4 oz.; 1-6 oz.
Pres. Sales Mgr. & Pur. Agt.—H. E. Cosselin
Vice Pres.—Frank R. Cosselin

●Butterfield, T. F., Inc., Naugatuck (C, I, T)
Compression Presses: 40-100 to 150 ton
Injection Machines: 7-202 to 80 oz.
Transfer Presses: 10-150 ton

*Colt's Plastics Co., Inc., Hartford (C, I)
Compression Presses: 8-100 ton; 42-80 ton; 12-40 ton; 4-80 ton
Injection Machines: 1-1½ oz.; 1-6 oz.; 4-8 oz.; 1-12 oz.
Pres.—Ernest Stroheim
Vice Pres.—W. C. Bentley
Sales Mgr.—Gregory J. Azarian
Pur. Agt.—L. F. Trouton

●*Connecticut Plastic Products Co., Inc., Waterbury (I, CM)
Injection Machines: 12-2 oz. to 16 oz.
Pres.—M. J. Kelly
V. Pres.—H. F. Reichenbuck
Sls. Mgr.—H. F. Reichenbuck
Pur. Agt.—M. F. Sullivan

●*Danielson Manufacturing Co., Danielson (I, E)
Injection Machines: 3-12 oz.; 6-4 oz.; 2-8 oz.; 2-1 oz.; 1-½ oz.; 1-5 oz.
Extrusion Machines: 2-1¼"; 1-2¼ in.; 1-3½ in.
Pres.—J. E. Holt
Vice Pres. & Sales—W. H. Chadbourne
Sales Mgr.—R. L. Sandin
Pur. Agt.—E. E. LaFantasie

●Davis-Standard, Div. of Franklin Research Co., Mystic (E)
Extrusion Machines: 1-½"; 2"; 2-¼"; 3"; 3-¼"; 4-½"; 6" & 8" sizes
Vice Pres.—Benjamin H. Davis
Sales Office Mgr.—Dennis Deveau
Pur. Agt.—Milton Hinsch

*Jessall Plastics, Inc., Kensington (E)
Extrusion Machines: 12 2-4½"
Pres.—C. F. Norberg
Vice Pres. & Gen. Mgr.—R. R. Zisette
Sales Mgr.—R. R. Zisette
Pur. Agt.—M. P. Skonieczny

*Meriden Molded Plastics, Inc., Meriden (C)
Compression Presses: 40 10 to 1500 ton
Pres., Vice Pres. & Sales Mgr.—George C. Kickson
Pur. Agt.—William J. Hall

Monoplastics Inc., Georgetown (I)
Injection Machines: 2 to 16 oz., 2-4 6-8-12-16 oz.
Pres. & Treas.—W. C. Monahan
Vice Pres. & Sales Mgr.—F. E. Monahan
Pur. Agt.—H. E. Sayers

●Plas-Tube, Inc., Springdale (I, E)

*Operates own tool room.
●Indicates Advertiser.

●**Plastene, Inc.,** White Plains (*I*)
Injection Machines: 1-6 oz., 2-8 oz., 1-10 oz., 1-12 oz., 1-16 oz.
Pres.—Bryce N. Batler
Sls. Mgr.—M. Hon. A. Batler
Pur. Agt.—Gerald Quinn

Plastic Film Corp., Planfield (*E*)
Extrusion Machines: 1
Pres. & Treas.—W. B. Nichols
Exec. Vice Pres. & Gen. Mgr.—A. C. Bruce
Vice Pres.—E. V. Disch
Sales Mgr. Industrial—T. A. Lancaster

●***Plastic Molding Corp.,** Sandy Hook (*C, I, T*)
Compression Presses: 75-20 to 350 ton
Injection Machines: 1-8 oz.; 212 oz.
Transfer Presses: 25-20 to 300 ton
Pres.—John W. Anderson
Vice Pres.—Kenneth B. Smith
Sales Mgr.—Donald B. Dyson
Pur. Agt.—W. A. Lank

***Plax Tube Inc.,** Hartford (*E*)
Extrusion Machines: 3-2½"
Pres.—R. Jacobb
V. Pres.—S. Jacobb
Sales Mgr. & Pur. Agt.—B. Moresca

Rowland Products, Inc., Kensington (*E*)
Extrusion Machines: 6-2½"; 1-2"
Pres. & Treas.—Hugh Rowland
V. Pres.—William P. Rowland, Paul K. Rogers
Pur. Agt.—Robert E. Randall

Shore Line Industries, Clinton (*E*)
Extrusion Machines: 3-4½; 1-3¼ 1-2
Pres.—Forrest B. Stannard
V. Pres.—John C. Wagner, Jr.
Sales Mgr.—Donald G. Fertman

●**Stanley Chemical Co.,** East Berlin (*I*)
Injection Machines: One-6 oz.; Two-2 oz.
Pres.—William H. Baldwin
V. Pres.—E. McKendree Hayden
Sales Mgr.—Arthur B. Sherry
Pur. Agt.—William H. Warren

Stelray Products, Inc., Suby. of Derby-Shelton Silver Co., Shelton (*I*)
Injection Machines: 2-8 oz.; 1-12 oz.

Teal Company, New Haven (*I, C*)
Injection Presses: 1-6 oz.; 3-6 oz.; 2-12 oz.
Compression Machines: 1-200 ton; 2-150 ton; 1-150 ton; 1-100 ton; 3-50 ton; 2-50 ton
Pres. & Sales Mgr.—Hugh F. Cook
Pur. Agt.—Arthur Quinn

***U. S. Plastic Molding Corp.,** Wallingford (*C, I, T*)
Compression Presses: 21 30 ton to 250 ton
Injection Machines: 3 9 oz. to 16 oz.
Transfer Presses: 6 75 ton to 250 ton
Pres. & Gen. Mgr.—George S. Scott
V. Presidents—S. & P. Barberino
Sales Mgr. & Pur. Agt.—George S. Scott

***Vogel Mfg. Co.,** Bridgeport (*I*)
Injection Machines: 8 machines, 2 to 20 oz.
Pres. & Sales Mgr.—Kurt M. Vogel
V. Pres.—Rudolf Vogel and Soren Graae

●***Waterbury Companies, Inc.,** Waterbury (*C, I, T*)
Compression Presses: 8-30 ton; 1-42T; 3-50T; 5-57 ton; 8-75T; 1-100T; 118T; 15-170T; 5-300 ton, 1-700T; 50 ton
Injection Machines: 2-4 oz.; 11-8 oz.; 1-12 oz.; 2-16 oz.; 1-35 oz.
Transfer Presses: 15-170 ton; 2-232 ton; 2-300 ton
Pres.—L. P. Sperry, Jr.
V. Pres.—W. F. Reibold
Sales Mgr.—G. A. Walker
Pur. Agt.—H. H. Carder

●***Watertown Mfg. Co.,** Watertown (*C, I*)
Compression Presses: 70-50 to 450 tons
Injection Machines: 12-2 oz to 64 oz.
Pres.—J. R. Neil
Vice Pres. & Sls. Mgr.—G. G. Welch
Sec.—H. J. Weisman
Treas.—C. M. Siemon
Pur. Agt.—C. M. Siemon, Jr.

DELAWARE

●***Continental-Diamond Fibre Corp.,** Newark (*C*)
Compression Presses: 12" x 12" to 36" x 36", 150 to 1200 ton, 50-150 ton; 10-1200 ton
Pres., Vice Pres. & Gen. Mgr.—H. K. Collins
Vice Pres.—E. O. Hausmann, J. F. Anderson, F. M. Grauer
Director of Sales—H. M. Dexter
Gen. Sales Mgr.—Arthur Briggs
Pur. Mgr.—W. H. Walker, Jr.

Haveg Industries, Inc., Wilmington (*C, T, E, CM*)
Compression Presses: 30 presses up to 5' x 7' up to 400 pounds
Transfer Presses: 2 up to 50 pounds
Extrusion Machines: 3 machines 1"-10'

●***National Vulcanized Fibre Co.,** Wilmington (*E*)
Extrusion Machines: up to 3½"
Pres.—E. R. Perry
Vice Pres.—F. I. Crow
Vice Pres. & Director of Sales—R. S. Fisher
Pur. Agt.—L. R. Clinton

FLORIDA

***Industrial Vinyls, Inc.,** Miami (*E*)
Extrusion Machines: 2-3½"; 1-4½"

***Varney, Inc.,** Miami (*I*)
Injection Machines: 2-4 oz.; 1-8 oz.; 2-4-6 oz.; 1-2 oz.
Pres.—Gordon Varney
V. Pres. & Secy.—N. J. Eppic
Sales Mgr. Plastics—N. J. Eppic
Pur. Agt.—Paul Koenigsberg

GEORGIA

Flexible Products Co., Marietta (*I*)
Injection Machines: 1-¾ oz.
Pres.—R. T. Henson
Vice Pres. & Sales Mgr.—Clyde Wilkins, Jr.
Pur. Agt.—S. F. Ruthland

ILLINOIS

***A. & O. Plastics Co.,** Downers Grove (*I*)
Injection Machines: 3-4 to 6 oz.
Pres. Sales Mgr. & Pur. Agt.—A. Nease
Vice Pres.—O. Nease

***Anesite Co.,** Chicago (*E*)
Extrusion Machines: 6
Pres.—William L. Hess
Vice Pres. & Treas.—G. L. Hess
Sales Mgr.—Joseph E. Stone
Pur. Agt.—A. W. Stadelmann

●***Artag Plastics Corp.,** Chicago (*I*)
Injection Machines: 1-4 oz.; 2-7 oz.; 8-8 oz.; 6-16 oz.
Pres.—Arthur Weis
Vice Pres.—Edward E. Heck
Sales Mgr.—Robert E. Reynolds
Pur. Agt.—Edward Heck

Bacon & Weber, Chicago (*CM*)

***Becwar Manufacturing Corp.,** Addison (*I, T*)
Injection Machines: 2-8 oz.; 1-3 oz.; 4-2 oz.
Transfer Presses: 1-25 ton

●***Blackhawk Molding Co., Inc.,** Addison (*I*)
Injection Machines: 5 from 4 oz. to 12 oz.
Pres. & Sales Mgr.—Walter E. Hidding
Vice Pres.—Jeannette W. Hidding
Pur. Agt.—Daniel P. Hidding

Bonell Plastics, Inc., Chicago (*I*)
Injection Machines: 5 3-4 oz.; 1-8 oz.; 1-12-16 oz.

***Cameron Inc.,** Chicago (*I*)
Injection Machines: 1-8 oz.; 1-10 oz.; 1-12 oz.; 1-16 oz.
Pres. & Sales Mgr.—L. C. Dunn
Vice Pres.—R. O. Nelson

●***Chicago Molded Products Corp.,** Chicago (*C, I, T, E*)
Compression Presses: 110 15 to 1500 ton
Injection Machines: 24 4 to 64 oz.
Transfer Presses: 35 75 to 520 ton
Extrusion Machines: 2" to 8"
Pres. & Gen. Manager—J. J. Bachner
Vice Pres. & Treas.—L. H. Bachner
Pur. Agt.—F. Klinenmeier
Vice Pres. & Mgr. Custom Molding Div.—J. E. Johnston
Vice Pres. & Mgr. Camco Div.—E. F. Bachner, Jr.

***Chicago Price Tag Mfg., Co.,** Chicago (*I*)
Injection Machines: 1-2 oz.

Chris Kaye Plastics Mfg. Co., Madison (*I*)
Injection Machines: 7 presses up to 16 oz.
Pres.—Christ D. Kacalieff

●***Commercial Plastics Co.,** Chicago (*I, E*)
Injection Machines: 13
Extrusion Machines: 1-3½", 12½", 1-1½".
Pres.—Anton Scharl
Vice Pres.—Raymond Alter
Sec. & Treas.—M. C. Kennedy
Sls. Mgr.—E. W. Heeter

***Crane Packing Co.,** Morton Grove (*C, E*)
Compression Presses:
Extrusion Machines:
Pres.—Karl V. Rohlen
Vice Pres.—Carl E. Schmitz
Sales Mgr.—Vance E. Vorbees
Pur. Agt.—V. Grogleth

*Operates own tool room.
●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

Cruver Mfg. Co., Chicago (*I*)
Injection Machines: 12-4 to 60 oz.
Pres.—C. L. Cruver, Jr.
Vice Pres.—James E. Starnes
Sales Mgr. & Pur. Agt.—John S. Clark

●***Davies, Harry, Molding Co.,** Chicago (*C, T*)
Compression: 25-75 to 300 ton
Transfer Presses: 15-130 to 300 ton
Pres.—J. F. Davies
Vice Pres.—Homer Beach & George E. Mullens
Pur. Agt.—I. Haugen

***Dielectric Materials Co.,** Chicago (*E*)
Extrusion Machines: 1-3½"; 1-3"; 1-2½"; 2-1½"
Pres.—H. D. Isenberg
Vice Pres.; Sales Mgr. & Pur. Agt.—O. C. Muenzer

Eclipse Manufacturing Co., Lake Zurick (*C, I, T*)
Compression Presses: 7-50 to 500 ton
Injection Machines: 2-9 oz.
Transfer Presses: 2-250 ton
Pres. & Pur. Agt.—J. L. Rackon
Vice Pres. & Sales Mgr.—Chas. Buckman

●***Federal Tool Corp.,** Chicago (*I, E*)
Injection Machines: 26
Extrusion Machines: 3
Pres.—R. Berhardt
Vice Pres.—J. Press
Vice Pres. & Sales Mgr.—R. Winter
Pur. Agt.—F. J. Sanders and Personnel Director & Treas.

***Felsenthal, G. & Sons,** Chicago (*I*)
Injection Machines: 18 4 oz. to 80 oz.
Pres. & Treas.—Ben W. Fau
Vice Pres.—Earl R. Keown, N. C. Rathner, J. H. Moses
Sales Mgr.—Earl R. Keown
Pur. Agt.—Burt Fredickson

***Fischer, Andrew, Associates,** Chicago (*E*)
Extrusion Machines: 3-2½
Pres. & Pur. Agt.—Andrew J. Fischer
Vice Pres. & Pur. Agt.—A. L. Larsen

●***General American Transportation Corp., Plastics Div.,** Chicago (*C, I, E*)
Compression Presses: 13 from 350 ton to 2000 ton
Injection Machines: 36 from 2 oz. to 300 oz.
Extrusion Machines: 9 2½" to 4½"
Pres.—William J. Stebler
Vice Pres.—Frank E. Selz
Pur. Agt.—Robert B. Silverman
Supervisor of Sales—James Nash

●***General Die Mold Co.,** Chicago (*C, I, T*)
Compression Presses: 11 from 30 to 450 ton
Injection Machines: 1-6 oz.; 1-9 oz.; 2-24 oz.; 1-32 oz.; 1-60 oz.
Transfer Presses: 4-150 ton
Pres.—Rose Nagy
Vice Pres. & Pur. Agt.—E. A. Berecz
Sales—S. T. Edlis

●***General Electric Co., Plastics Department,** Decatur (*C, I, T, E*)
Compression Presses: 1-15-33; 25-30; 45-50; 65-54; 75-1; 100-30; 140-150-28; 22-240-22; 275-10; 300-8; 400-425-7; 575-600-3, 1200-1400-3 tons
Injection Machines: 1½-3; 8-8; 12-8; 16-10; 22-32-8; 48-3; 60-4; 200-2 oz.
Transfer Presses: 0-15; 25-20; 45-32; 65-26; 75; 100-15; 140-150-8; 220-240-10; 275-8; 300 through 1400 tons
Extrusion Machines: 2"-4; 2½"-2

***General Molded Prod., Inc.,** Des Plaines (*C*)
Compression Presses: 24-50 to 1000 ton
Pres.—N. A. Anderson
Vice Pres. & Secy.—C. J. Sanders, E. Anderson
Sales Mgr.—D. Goll
Pur. Agt.—H. Matheson

Ger-Ell Mfg. Co., Chicago (*I*)
Injection Machines: 9 1-8 oz.; 1-12 oz.; 5-16 oz.; 1-24 oz.; 1-200 oz.

Grigoleit Co., Decatur (*C, I, T*)
Compression Presses: 90 30 ton to 600 ton
Injection Machines: 4 4 oz. to 12 oz.
Transfer Presses: 15 100 ton to 300 ton
Pres.—J. L. Howie, Jr.
Vice Pres. & Gen. Mgr.—R. K. Howie
Sales Mgr.—Carl A. Goltermann
Pur. Agt.—A. P. McMinn

●**Holland, M., Co.,** Chicago (*E*)
Extrusion Machines: 1-4½"; 1-3¼"; 1-2½"
Pres.—M. Holland

●***Industrial Molded Prod. Co.,** Palatine (*C, I, T*)
Compression Presses: 20 88 to 350 tons
Injection Machines: 2 1-8 oz.; 1-16 oz.
Transfer Presses: 5 88 ton to 350 tons
Pres.—Carl E. Benson
Vice Pres. & Treas.—Peter C. Barsanti
Sales Mgr.—Robert Monroe
Pur. Agt.—Peter C. Barsanti

●***Johnson Glass & Plastic Corp.,** Chicago (*I*)
Injection Machines: 3 8-20 oz.
Pres.—William Garland
Vice Pres.—William W. Garland
Pur. Agt.—H. E. Garland

●***Koolyn Plastics, Inc.,** Chicago (*I*)
Injection Machines: 1-2 oz.; 1-3 oz.; 1-4 oz.; 2-6 oz.; 1-9 oz.; 1-16 oz.
Pres., Treas. & Pur. Agt.—W. D. McKay
Vice Pres.—J. E. Glatt

***Korris Products, Inc., Lyons** (*I*)
Injection Machines: 1-2 oz., 1-4 oz., 3-8 oz., 2-16 oz.
Pres.—Charles Youdris
Vice Pres.—Lido Albiani
Secy. & Treas.—E. J. Koren

***Mager & Gougelman Plastic Molding Corp.,** Chicago (*I*)
Injection Machines: 1-8 oz.; 5-12 oz.; 1-16 oz.
Pres. & Pur. Agt.—Paul Gougelman
Vice Pres. & Sales Mgr.—Stanley Rybak

●***Makray Manufacturing Co.,** Chicago (*I*)
Injection Machines: 1-4 oz.; 10-9 oz.; 1-12 oz.; 9-16 oz.; 1-20 oz.; 2-32 oz.; 2-60 oz.
Pres. & Treas.—P. Makray
Sales Mgr.—A. Maclachlan
Production Mgr.—R. Mooy

Mallory Plastics Co., Chicago (*C, I, T*)
Compression Presses: 3-250 ton; 11-300 ton; 1-600 ton
Injection Machines: 2-4 oz.; 5-8 oz.; 2-12 oz.; 1-16 oz.
Transfer Presses: 2-75 ton, 4-110 ton, 3-200 ton; 7-250 ton; 3-300 ton; 2-450 ton
Vice Pres. & General Mgr.—R. R. Forbes
Vice Pres.—F. J. Krone
Pur. Agt.—Harry C. Swanson

***Mayfair Molded Products Corp.,** Franklin Park (*C, T*)
Compression Presses: 40 up to 350 tons
Transfer Presses: 4 to 200 tons
Pres.—Luther J. Evans
Vice Pres.—Robert Theis
Sales Mgr.—Glenn Adams

●**Midwest Molding & Mfg. Co.,** Waukegan (*C, I*)
Compression Presses: 20 80 to 350 tons
Injection Machines: 6 4 oz. to 12 oz.
Pres.—E. R. O'Connor
Vice Pres. & Sec.—T. E. Rochards

●***Midwest Plastics Products Co.,** Chicago Hts. (*E*)
Extrusion Machines: 1-4½"; 2-3½"; 2-2½"
Pres. & Pur. Agt.—E. E. Eckenbeck, Sr.
Vice Pres. & Sales Mgr.—C. C. Whitacre

●***Molded Products, Div. of Admiral Corp.,** West Chicago (*C, I, T*)
Compression Presses: 31 20 to 3000 tons
Injection Machines: 8 4 oz. to 80 oz.
Transfer Presses: 1 30 ton 1-114 ton
Works Mgr.—James H. Chamberlain
Sales Mgr.—Raymond T. Leahy
Pur. Agt.—James J. Pellegrino

Multiplastics, Div. of Curd Enterprises, Addison (*C*)
Compression Presses: 1-24 x 13' 100 ton
Pres.—R. F. Curd, Jr.
Sales Mgr.—Don Lence
Pur. Agt.—Iona Brannon

National Lock Co., Rockford (*C, I, E*)
Compression Presses: 4-50 ton; 2-100 ton; 13-250 ton; 1-750 ton
Injection Machines: 2-4-6 oz.; 4-8 oz.; 2-12-6 oz. and 1-22 oz.
Extrusion Machines: 3-2½"; 1-4½"

●***Paragon Molding Co.,** Melrose, Ill. (*I*)
Injection Machines: 4
Pres.—W. W. Wright
Vice Pres. & Sec.—A. H. Wright

***Perfex Plastics, Inc.,** Chicago (*I, E*)
Injection Machines: 3
Extrusion Machines: 6
Pres.—B. B. Manaster
Vice Pres.—S. S. Eliot, E. Wilson
Pur. Agt.—S. C. Ehrenberg

***Peoria Plastic Co.,** East Peoria (*I*)
Injection Machines: 2-8 oz.; 1-16 oz.; 2-48 oz.
Pres.—R. W. Wendland
Vice Pres. & Sales Mgr.—W. M. Chinuge
Pur. Agt.—Earl Malchow

***Plano Molding Co.,** Plano, Ill. (*C, I, T*)
Compression Presses: 7 presses, 50 ton to 300 ton
Injection Machines: 8 machines, 4 oz. to 20
Transfer Presses: 4 transfer, 60 to 400 ton
Pres. James L. Henning
VicPres. & Sales Mgr.—R. C. Yunger
Pur. Agt.—L. E. Phelps

●***Plasticrafters, Inc.,** Chicago (*C, I, T*)
Compression Presses: 1-200 ton; 1-500 ton; 1-600 ton
Injection Machines: 4-8 oz.; 1-16 oz.
Transfer Presses: 2-200 ton
Pres.—James A. Boyajian
Vice Pres.—E. L. Boyajian
Sales Mgr.—Robert Jacobsen
Pur. Agt.—A. C. Tork

---

*Operates own tool room.
●Indicates Advertiser.

●*Plastic Molded Products Co., Chicago (*I*)
Injection Machines: 2–36 oz.; 1–12 oz.; 2–10 oz.; 3–8 oz.
Pres. & Pur. Agt.—H. Wm. Brandt
Vice Pres.—Alois Landaver
Sales Mgr.—Charles Trabor

*Polymold Plastics, Inc., Chicago (*I*)
Injection Machines: 1–2 oz.; 4–8 oz.; 3–12 oz.; 3–16 oz.; 1–20 oz.
Pres., Treas. & Sales Mgr.—Ben Polikoff
Vice Pres., Gen. Mgr. & Pur. Agt.—J. C. Porcelli

●*Process Gear Co., Chicago (*I*)
Injection Machines: 4–3 oz.
Pres. & Sales Mgr.—H. J. Monger
Pur. Agt.—Len Wichman

Pyramid Plastics, Inc., Chicago (*E*)
Extrusion Machines: 5–2½"
Pres.—James A. Palmer
Vice Pres.—R. J. Huber
Sales Mgr.—Webster D. Paton

*Republic Molding Corp., Chicago (*C, I*)
Compression Presses: 6–50 to 400 tons
Injection Machines: 25–8 oz. to 120 oz.
Pres.—Bertram W. Coltman
V. Pres.—Bertram W. Coltman, Jr.
Sales Mgr.—Bart J. McCloskey
Pur. Agt.—Richard C. Klebbe

*Resincraft Plastics, Inc., Chicago (*E*)
Extrusion Machines: 3 1–3½"; 2–2½"
Pres. & Sales Mgr.—Stanley Wexler
V. Pres.—Leonard Becker
Pur. Agt.—Leonard Becker

●Resinoid Engineering Corp., Skokie (*C*)
Compression Presses: 16
Pres.—Clarence A. Herbst, Sr.
Vice Pres.—Clarence A. Herbst, Jr.

●*Richardson Company, Melrose Park (*C, I, T*)
Compression Presses: Multi-plant facilities with range of sizes
Injection Machines: same
Transfer Presses: same
Sales Mgr.—R. W. Jorgensen
V. Pres. & Director of Plastic Sales—R. W. Jorgensen
Pur. Agt.—B. L. Allen

*Rockford Molded Products, Rockford (*C, I, T*)
Compression Presses: 2–100 ton
Injection Machines: (3) 4 oz.; (2) 12 oz.
Transfer Presses: (1) 100 ton; (1) 200 ton; (1) 300 ton
Pres. and Gen. Mgr.—Henry W. Gustafson

●*Rogan Bros., Skokie (*C, T*)
Compression Presses: 6–15 tons; 6–50 tons; 4–125 tons; 2–150 tons
Transfer Presses: 2–150 tons
Pres.—Ed. Rogan (Partners)
V. Pres.—J. J. Rogan (Partners)

*Romar Plastics, Inc., St. Charles (*C, I, T*)
Compression Presses: 8–50 to 250 tons
Injection Machines: 4–4 oz. to 8 oz.
Transfer Presses: 8–50 to 250 tons
Pres.—R. E. Peterson
V. Pres.—M. A. Peterson
Sales Mgr.—A. Czarnecki
Pur. Agent—G. E. Hart

*Rosenberg Bros. & Co., Smithtown (*E*)
Extrusion Machines: 4 extruders
Pres. & Sales Mgr.—Mike Rosenberg
V. Pres.—Ross Rosenberg
Pur. Agt.—Joseph Rosenberg

●*Sandee Mfg. Co., Chicago (*E*)
Extrusion Machines: 17
Pres. & Sales Mgr.—E. D. Szantay
Pur. Agt.—J. A. Claerhout

●*Santay Corp., Chicago (*I*)
Injection Machines: 2–3 oz.; 1–4 oz.; 3–6 oz.; 2–8 oz.; 4–9 oz.; 1–12 oz.; 2–16 oz.; 1–24 oz.; 2–32 oz.; 1–48 oz.; 1–60 oz.

●Service Plastics, Inc., Chicago (*I*)
Injection Machines: 1–85 oz.; 1–48 oz.; 1–32 oz.; 1–20 oz.; 1–20 oz.; 2–12 oz.; 1–12 oz.; 1–8 oz.; 1–4 oz.; 1–2 oz.
Pres., Sales Mgr., Pur. Agt., Secy. & Treas.—Maurice Meltzer
V. Pres.—Charles Karels

*Stimsonite Div.—Elastic-Stop Nut Corp of America, Chicago (*I*)
Injection Machines: H. P. M. 32 oz.-2; Lester 12 oz.-2; 4 oz.-1; Lester 48 oz.-1; H. P. M. 16 oz.-5; H. P. M. 9 oz.-4
Pres.—W. F. Maguiness
V. Pres.—Mr. I. Mack
Sales Mgr.—E. A. Peterson

●*Superior Plastics, Inc., Chicago (*I, E*)
Injection Machines: 17 machines: 24 oz.; 8 oz.; 4 oz.; 12 oz.; 16 oz.; 20 oz.
Extrusion Machines: 6, 3½"; 2½"
Pres.—Harry Scheer
V. Pres.—Louis Levine
Sales Mgr.—Richard S. Bezark
Pur. Agt.—Ed. Pignataro

●*Trans-Matic Plastics Co., Chicago (*C, I*)
Compression Presses: 13 to 150 ton
Injection Machines: 3 to 8 oz.
Pres.—Stephen J. Handzel
Sales Mgr.—Allan McConnell

●*20th Century Plastics Co., Chicago (*I*)
Injection Machines: 2–16 oz.; 2–12 oz.; 1–eight; 1–four
Pres.—Nathan Nudelman
V. Pres.—Bernard Willow
Sales Mgr.—J. H. DeSobe
Pur. Agt.—Josephine Bavaro

*Van Norman Molding Co., Chicago (*C, T*)
Compression Presses: 4–15 ton; 2–30 ton; 6–50 ton; 5–100 ton; 1–125 ton; 1–200 ton
Transfer Presses: 1–100 ton; 3–200 ton
Pres. & Gen. Mgr.—G. E. Andre
Pur. Agt. & Supt.—R. P. Harrison

●*Victory Mfg. Corp., Chicago (*I*)
Injection Machines: 2–60 oz.; 3–32 oz.; 4–16 oz.; 2–12 oz.; 4–9 oz.; 2–8 oz.; 1–4 oz.; 1–2 oz.
Pres. & Sales Mgr. For Custom Edward Singer
Exec. V. Pres.—Harold L. Samuels
V. Pres. & Gen. Mgr.—Edward F. Abbott
Pur. Agt.—Charles Dorband

*Whitso, Inc., Schiller Park (*C, I, T*)
Compression Presses: (3) 90T
Injection Machines: (1) 4 oz.
Transfer Presses: (12) to 150 T
Pres.—John B. Whitted
V. Pres.—John B. Whitted, Jr.
Sales Mgr.—John W. Shannon

●*Albert Zollinger, Inc., Downers Grove (*C, I, T*)
Compression Presses: 1–15 ton; 1–30 ton; 1–150 ton
Injection Machines: 1–4 oz.
Transfer Presses: 2–150 ton; 3–200 ton; 1–300 ton; 1–88 ton
Pres.—Albert Zollinger
V. Pres. & Pur. Agt.—Robert Zollinger
Sales Mgr.—Norman Zollinger

INDIANA

*AGP Corporation, Peru (*I*)
Injection Machines: 2–2 oz.; 1–3 oz.; 1–6 oz.; 3–8 oz.; 1–16 oz.
Pres.—Geo. L. Lawrence
Vice Pres.—C. Lyman Hall
Sales Mfg.—John E. King
Pur. Agt.—Gerald M. Ellars

●*Como Plastics, Inc., Columbus (*I*)
Injection Machines: 1–4 oz.; 1–4–6 oz.; 2–8 oz.; 2–12 oz.; 2–16 oz.; 1–20 oz.; 1–28 oz.
Pres. & Sales Mgr.—James L. Russell
Vice Pres.—Oscar Daffron
Pur. Agt. & Secy.—Ray A. Lain

●*Crescent Plastics, Inc., Evansville (*E*)
Extrusion Machines: 8 machines up to 4½"
Pres.—John H. Schroeder
Vice Pres.—Clem J. Young
Sales Mgr. & Custom Sales—Don Korb
Pur. Agt.—Samuel Clifford

Crown Tool, Inc., Wabash (*I*)
Injection Machines: 2–2½ oz.
Pres.—James M. Hipsher
Vice Pres., Treas. & Sales Mgr.—Leo R. Kastner

*Engineered Nylon Products, Inc., South Bend (*I*)
Injection Machines: 2–4 oz.; 3–8 oz.; 2–12 oz.
Pres.—Richard W. Bosse
Vice Pres. & Gen. Mgr.—Edward Tubbs
Sales Mgr.—Wayne Mansfiels
Pur. Agt.—Robert E. Lee

●*General Plastics Corp., Marion (*E*)
Extrusion Machines: 2–3½"
Pres.—Henry L. Erlewine
Vice Pres. & Sales Mgr.—Richard H. Erlewine
Pur. Agt.—C. W. Richter

Industrial Plastics Corp. Elkhart (*E*)
Extrusion Machines: 1–1½"; 3–2½"; 1–3½"
Pres. & Sales Mgr.—C. A. Moffat
Vice Pres.—R. K. Moffat
Pur. Agt.—L. J. Swift

*Kenly Co., Terre Haute (*I*)
Injection Machines: 9–12–16 oz.
Partners—Kenneth Uran & Lyman Pandercast

*Niles Corp., So. Bend (*I*)
Injection Machines: 1–8 oz.; 1–4 oz.
Pres., Sales Mgr. & Pur. Agt.—Loren Schafer
Vice Pres.—M. A. Schafer

●Polygon Plastic Company, Walkerton (*E*)
Extrusion Machines: Fiber glass extrusion machines: patented continuous process
Pres.—S. M. Shobert
Vice Pres.—G. S. Parks
Sales Mgr.—E. R. Jaques

Pribble Plastics Products, Inc., New Haven (*C*)
Compression Presses: 2–25 ton; 2–75 ton; 1–283 ton

---

*Operates own tool room.
●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

Transfer Presses: 5
Pres., Sales Mgr. & Pur. Agt.—Wayne I. Pribble
Vice Pres.—John L. Haugsrud (Plant Mgr.)

***Progressive Molded Products Corp.,** Bluffton (*T*)
Transfer Presses: 4–75 to 300 ton
Pres., Treas., Sales Mgr. & Pur. Agt.—Philip H. Leonard

Sheller Mfg. Corp., Portland (*C, I*)
Compression Presses: 1–480 ton; 8–500 ton; 78–135 ton
Injection Machines: 1–8 oz.; 2–22 oz.; 2–28 oz.; 2–40 oz.
Pres.—T. Bradley
V. Pres. & Gen. Mgr.—J. A. McKeown
Sales Mgr. & V. Pres.—E. J. Cosgrave
Pur. Agt.—E. J. Minch

***Square D. Co.,** Peru (*CM, C, T*)
Compression Presses: 38–50 ton; 3–75 ton; 2–100 ton; 7–150 ton; 1–200 ton; 3–300 ton
Transfer Presses: 7–50 ton; 3–150 ton; 6–200 ton; 1–300 ton
Plant Mgr.—C. G. Schini
Factory Mgr.—F. G. Ahnert
Sales Mgr.—T. E. Adams
Pur. Agt.—D. L. Rouch

***Wayne Plastics Corp.,** Ft. Wayne (*C, I, T*)
Compression Presses: 2–125 ton; 2–250 ton; 2–50 ton
Injection Machines: 1–2 oz.; 1–4 oz.
Transfer Machines: 1–115 ton; 1–200 tons; 1–300 tons
Pres.—R. H. Fletcher
Sales Mgr.—W. W. Burhop
Pur. Agt.—Harold Parker

KENTUCKY

***Tri-State Plastic Molding Co.,** Henderson (*I*)
Injection Machines: 32 oz. –1; 24 oz. –1; 12 oz. –4; 8 oz. –9; 4 oz. 2; 2 oz. –1
Pres.—P. J. Buckley
V. Pres.—Leo King
Sales Mgr.—Gordon R. Kay
Pur. Agt.—Joseph Mis

***Tube Turns Plastics, Inc.,** Louisville (*I*)
Injection Machines: Unplasticized Polyvinyl Chloride up to 190 ounces maximum capacity
Pres.—George O. Boomer
V. Pres.—Carl B. McLaughlin
Sales Mgr.—Earl A. Erich
Pur. Agt.—Joseph P. Knopf

MAINE

Keyes Fibre Co., Waterville (*C*)
Compression Presses: 13–200 to 1000 ton
Pres.—W. E. Parsons
Vice Pres. & Gen. Mgr.—R. H. Cutting
Director of Marketing—H. D. Archibald
Pur. Agt.—R. M. Wescott

MARYLAND

Chance, W. R., & Associates, Inc., Waldorf (*CM*)
Pres.—W. R. Chance
Sales Mgr.—D. P. Hains

***Fawn Plastic Co., Inc.,** Baltimore (*I*)
Injection Machines: 1–3 oz.; 1–8 oz.; 2–6 oz.
Pres. & Pur. Agt.—Robert D. Brickett
Vice Pres.—John Franzone
Sales Mgr.—William Reese

***Maryland Plastics, Inc.,** Federalsburg (*C, I*)
Compression Presses: 22–150 ton; 1–50 ton
Injection Machines: 1–3 oz.; 2–4 oz.; 1–6 oz.; 2–8 oz.; 1–12 oz.; 1–20 oz.
Pres.—Samuel Lidz
Vice Pres.—Leo K. Stupeel, Allen M. Penrod
Sales Mgr.—Gordon C. Prickett

***Mold Craft Inc.,** Baltimore (*C, I*)
Compression Press: 7–50 ton; 8–25 ton
Injection Machines: 2–3 oz.; 2–12 oz.; 2–16 oz.
Pres.—David H. DeVilliers
Vice Pres. & Pur. Agt.—F. S. Nixdorff
Sales Mgr.—Lok L. Wargo

●*National Plastic Products Co., Odenton (*I, E*)
Injection and Extrusion Machines:
Pres.—E. Winer
V. Pres.—A. Winer
Sales Mgr.—J. R. Brown
Pur. Agt.—D. J. Anderson

The Wama Company, Baltimore (*C*)
Compression Presses: 1–50 ton; 1–100 ton
Pres.—S. K. Bodine
V. Pres.—W. D. White
Sales Mgr.—H. H. Robbins

MASSACHUSETTS

●Bolta Products Div., General Tire & Rubber Co., Lawrence (*I*)
Injection Machines: over 20 from 6 oz. to 48 oz.
Gen. Mgr.—John Bolten, Sr.
Gen. Sales Mgr.—Sumner L. Trilling
Pur. Agt.—Wayne Grubaugh

Boyden Plastics, Inc., Taunton (*C, I, T*)
Compression Press: 1 50 ton; 1 120 ton
Injection Machines: 4 8 oz.; 1 12 oz.
Pres.—Howard C. Boyden

Brook Molding Corp., Norwood (*C, I, T*)
Compression Presses: 6 170 to 600
Injection Machines: 2 4 oz.; 2 12 oz.
Transfer Presses: 5 170 to 300
Pres.—F. Reed Estabrook, Jr.
Vice Pres.—Wm. J. Mixter, Jr.
Sales Mgr. & Vice Pres.—Colin M. Cunningham

Century Plastic Co., Fichburg (*I*)
Injection Machines: 7 4–22 oz.

Church, C. F., Div. of American-Standard, Holyoke (*C, I, T*)
Compression Presses: 84–80 to 300 tons
Injection Machines: 20–6 to 80 oz.
Transfer Presses: 10–80 to 300 tons
Pres.—R. A. Witherell
Vice Pres.—S. L. Young
Sales Mgr.—R. Kolstad
Pur. Agt.—L. Shaw

***Commonwealth Plastics Corp.,** Leominster (*I, E*)
Injection Machines: 37 12–8 oz.; 3–0 oz.; 8–4 oz.; 4–16 oz.; 3–3 oz.; 2–4–6 oz.; 5–12 oz.
Extrusion Machines: 12 total: 6 ea. 2½ size; 4 ea. 3½ size; 2 ea. 1½ size
Pres.—Harry Levine
Vice Pres. & Gen. Mgr.—Morton Levine
Sales Mgr.—Sol Birnbaum
Pur. Agt., Secy. & Ass't Treas.—Edward W. Carlson

***Deerfield Plastics Co., Inc.,** South Deerfield (*E*)
Extrusion Machines: 4–2" to 4½"
Pres.—Kenneth R. Barker
Vice Pres. & Production Mgr.—Elloitt R. Barker, Jr.
Pur. Agt.—E. A. Mieg (Mrs.)

●Foster Grant Co., Inc., Leominster (*I*)
Injection Machines: 80 mch. 202 to 4802
Pres. —Joseph C. Foster
Sales Mgr.—John La Belle
Pur. Agt.—Charles Loiselle

●*Kingsman, E. B. Co., Inc., Leominster (*I, E*)
Injection Machines: 3–4 oz.; 1–2 oz.; 7–8 oz.; 1–20 oz.
Extrusion Machines: 2–2½"
Pres.—S. F. Behr
V. Pres., Sales Mgr. & Pur. Agt.—Richard H. Howe

●Morningstar Corp., Cambridge (*I*)
Injection Machines: 1–4 oz.; 1–6 oz.; 2–8 oz.; 3–12–16 oz.; 4–16 oz.; 1–32 oz.
Pres.—Otto Morningstar
Sales Mgr.—George E. Gross
Pur. Agt.—Emanuel Morningstar

***Northern Industrial Chemical Co., Inc.,** Boston (*C, I, T*)
Compression Presses: 125 up to 500 ton
Injection Machines: 12 up to 22 oz.
Transfer Presses: 15 up to 300 ton
Pres.—Albert B. Bower
Vice Pres.—Hans H. Wanders
Treas.—John B. Eliot
Sls. Mgr., Industrial—H. Philip Causer
Sls. Mgr., Consumer Prod.—Robert E. La Fortune
Pur. Agt.—Ralph Serriello

●*Reed Plastics Corp., Worcester (*E*)
Extrusion Machine: 4–3½ to 4½
Pres.—Milton S. Shefter
Sls.—Henry W. Cox
Pur. Agt.—Alfred L. Cox

●*Sheffield Plastics, Inc., Sheffield (*E*)
Extrusion Machines: 3–3½" & 2½"
Pres.—H. R. Stover
Sls. Mgr.—J. B. Orr
Pur. Agt.—J. E. Mullen

MICHIGAN

Ameriplastic Co., Flint (*CM*)
Pres., V. Pres. & Sales Mgr.—Joel S. Graves
Pur. Agt.—Virginia M. Cook

***Bangor Plastics, Inc.,** Bangor (*C, T*)
Compression Presses: 21, from 30 ton to 640 ton
Transfer Presses: 2 1–30 ton; 1–250 ton
Pres.—Victor Miller
Vice Pres., Treas. & Sales Mgr.—E. O. Wokeck
Pur. Agt.—G. F. Wokeck
Secy.—G. F. Wokeck

●*Cadillac Plastic & Chemical Co., Detroit (*E*)
Extrusion Machines: 1–3½"; 1–1"
Pres.—Robert B. Jacob
Vice Pres.—Richard J. Jacob
Sales Mgr.—Lloyd R. Marentette
Pur. Agt.—Frank Barnard

●Detroit Macoid Corp., Detroit (*I, E*)
Injection Machines: 3–8 oz.; 2–16 oz.
Extrusion Machines: 16

---

*Operates own tool room.
●Indicates Advertiser.

Pres.—G. S. Hendrie, Sr.
Vice Pres. & Treas.—J. E. Gould
Sales Mgr.—J. E. Gould
Pur. Agt. & Secy.—S. D. Bradley

Duralastic Products Co., Detroit (*C*)
Compression Presses: 20
Pres. & Sales Mgr.—Joseph N. Epel
Vice Pres.—Julius Barach
Pur. Agt.—James R. Pollock
Project Engineer—Clyde J. Hamner
Maintenance Eng.—Walter Grimes

***•Electric Auto-Lite Co.,** Bay City (*C, I, T*)
Compression Presses: 44–15 to 423 ton
Injection Machines: 48–4 to 28 oz.
Transfer Presses: 25–50 to 350 ton
Vice Pres. & Gen. Mgr.—C. M. Adams
Sales Mgr.—J. P. Kelso
Pur. Agt.—H. Ricker

•Fabricon Products—Div. Eagle Picher, River Rouge (*C*)
Compression Presses: 15 up to 200 tons
Pres.—L. A. Fisher
Ass't to the Pres.—C. L. Keller
Sales Mgrs.—J. T. Galvin, R. C. Fontham, C. E. Feltner
Pur. Agt.—J. E. Steiner

***Frank Plastics Corp.,** Detroit (*E*)
Extrusion Machines: 2
Pres.—L. C. Frank, Jr.
Vice Pres.—Joseph Morrison—Sales
Production—Leon Price
Pur. Agt.—R. M. Young

***General Machine & Tool Wks., Inc.,** Walled Lake (*I*)
Injection Machines: 1–400 oz.; 1–300 oz.; 1–120 oz.; 1–80 oz.; 1–60 oz.; 4–32 oz.; 2–8 oz.; 1–4 oz.
Pres., Sales Mgr. & Pur. Agt.—George Kovacs
Vice Pres.—E. E. Abbott

***Haas Corp.,** Mendon (*C, I, T*)
Compression Presses: 3–50 ton; 1–100 ton
Injection Machines: 2–6 oz.; 2–8 oz.; 1–12 oz.; 1–16 oz.; 1–32 oz.
Transfer Presses: 2–50 ton; 5–100 ton; 4–150 ton; 2–175 ton; 3–200 ton; 1–400 ton; 3–675 ton
Pres.—Paul C. Haas
Sales Mgr.—Carroll J. Haas
Pur. Agt.—Norman H. Haas

Hoffman Industries, Inc., Spring Arbor (*I*)
Injection Machines: 1–4 oz.; 1–8 oz.; 1–12 oz.; 1–6 oz.
Pres.—John J. Hoffman
Vice Pres.—E. F. Hoffman
Secy & Treas.—W. P. Hoffman

Hughes Plastics, Inc., St. Joseph (*I*)
Injection Machines: 3–4 oz.
Pres.—Kent H. Hughes
Sales Mgr. & Secy.—R. S. Kasischke
Treas.—M. W. Hughes

Lus/Trus Corp., Ypsilanti (*E*)
Extrusion Machines: 4–2"; 1–2½"; 1–3½"
Pres. & Pur. Agt.—E. E. Magnuson
Vice Pres.—R. O. Bonisteel
Sales Mgr.—H. L. Grafton

***McDonald Manufacturing Co.,** New Baltimore (*I*)
Injection Machines: 1 3 oz.; 1 4 oz.; 1–8 oz.; 3–8 oz.; 1–9 oz.; 1–16 oz.; 1–22 oz.; 1–48 oz.; 2–64 oz.

Pres.—Stuart MacDonald
Vice Pres.—J. H. Kuhn
Plant Mgr.—Scott Walker
Pur. Agt.—Don Morrish

•*Michigan Chrome & Chemical Co., Detroit (*E*)
Extrusion Machines: 6 up to 3"
Pres.—James A. Palmer
Sales Mgr.—Webster D. Paton

•Michigan Plastic Products, Inc., Grand Haven (*I*)
Injection Machines: 2–8 oz.; 1–4 oz.; 2–16 oz.; 2–20 oz.; 1–32 oz.
Pres. & Gen. Mgr.—Miller G. Sherwood
Vice Pres.—Marion A. Sherwood
Sales & Plant Mgr.—Charles F. Maitzen
Pur. Agt.—Melvin E. Frost

Michigan Panelyte Molded Plastics, Inc., Dexter (*C, T, E*)
Compression Presses: 1–35 ton; 10–50 ton; 5–150 ton; 1–300 ton; 1–500 ton; 6–100 ton; 10–200 ton; 1–400 ton; 3–30 ton
Transfer Presses: 1–300 ton; 5–200 ton
Extrusion Machines: 1–4 oz.; 4–10 oz.; 1–6 oz.; 2–8 oz.; 5–12 oz.; 4–16 oz.; 1–32 oz.; 1–48 oz.
Pres.—John G. Rossiter
Vice Pres.—Dan Vass
Sales Mgr.—V. L. Kiernan
Pur. Agt.—W. K. McGee

***Mitchell Plastics, Inc.,** Owosso (*I*)
Injection Machines: 1–8 oz.; 1–9 oz.; 1–12 oz.; 3–16 oz.; 1–32 oz.; 1–48 oz.
Pres.—William F. Mitchell
Vice Pres.—Thomas S. Drabek
Gen. Mgr.—Henry L. Miller
Factory Mgr.—Ladd E. Houdek
Plant Supt.—James A. Burton

***Modern Plastics Corp.,** Benton Harbor (*C, I, T*)
Compression Presses: 30 35 to 1200 ton
Injection Machines: 4 oz. to 60 oz.
Transfer Presses: 25 35 to 500 ton
Pres.—V. A. Miller
Vice Pres. & Gen. Mgr.—O. E. Skelton
Secy. & Treas.—S. O. Miller
Pur. Agt.—R. Smikle

***Plasticles Corp.,** Detroit (*C*)
Compression Presses: 2–18 x 24 and 36" x 40"
Pres.—John C. Demunter
Vice Pres.—Buryl L. Clack
Sales Mgr.—James M. MacKinnon
Pur. Agt.—Buryl L. Clack

***Plasticraft Inc.,** Denver (*I*)
Injection Machines: 1–1 oz.; 1–5 oz.
Pres. & Pur. Agt.—T. H. Cooper
Vice Pres. & Sales Mgr.—B. B. Butcher

Plastic Masters, Inc., New Buffalo (*C*)
Compression Presses: 1–600 tons; 2–280 tons; 3–175 tons; 2–150 tons; 1–125 tons; 1–45 tons; 3–20 oz. 3–12 oz.
Pres.—Victor A. Miller
Vice Pres.—Owen E. Skelton
Gen. Mgr.—Carl G. Marquardt
Sales Mgr.—Richard P. Smith
Purchasing Agt.—Bernard A. Guerrettaz

Plastray Corporation, Detroit (*I*)
Injection Machines: 11–4 oz. to 24 oz. capacity
Pres. & Sales Mgr.—D. L. Jocelyn
Vice Pres.—R. H. Close
Pur. Agt.—L. P. Rossier

***Quick Plastics,** Jackson (*E*)
Extrusion Machines: 2–2½"
Pres.—Robert Ilfeld
V. Pres.—Robert Culp
Sales Mgr.—Henry Jones
Pur. Agt.—Miss Evelyn Solmon

Reynolds Plastics, Inc., Walled Lake (*C*)
Compression Presses: 2–100 ton and 8 ton
Pres.—George Kovacs
V. Pres.—H. B. Ben, J. A. Soltis
Sales Mgr.—H. B. Ben
Pur. Agt.—R. Wallet

***Robbins, Jim, Company,** Royal Oak (*I, E*)
Injection Machines: 6–4 oz.; 5–9 oz.; 1–12 oz.; 8–16 oz.; 2–100 oz.
Extrusion Machines: 2-Extruded Pellitizer
Pres.—J. M. Robbins
V. Pres.—H. G. Michael
Sales Mgr.—W. L. Johnson
Pur. Agt.—W. W. Cornwall

St. Clair Plastics Corp., Marine City (*I*)
Injection Machines: 1–4 oz.; 1–8 oz.; 1–10 oz.; and 1–12/16 oz.
Pres. Sales Mgr. & Pur. Agt.—A. Kindsvater
V. Pres.—Chase S. Osborn

•Schwab Plastics Corp., Detroit (*E*)
Extrusion Machines: 2 machines 2½"; 3 machines 1"
Pres. & Sales Mgr.—Fred E. Schwab
V. Pres.—Paul C. Roche
Pur. Agt.—Lewis C. Fantle

***W-L Molding Company,** Kalamazoo (*C, I, T*)
Compression Presses: 1 30 ton; 1–20 ton; 2–100 ton; 1–200 ton; 2–250 ton
Injection Machines: 1–6 oz.; 2–8 oz.; 2–20 oz.
Transfer Presses: 1 30 ton; 1 20 ton; 1–100 ton; 2 250 ton
Pres. & Sales Mgr.—Geo. R. Laure
V. Pres.—E. L. Laure
Pur. Agt.—J. P. Nielsen

MINNESOTA

***Mayon Plastics,** Hopkins (*E*)
Extrusion Machines: 3–2½"; 1–3½"
Partners—C. B. Thomas, R. D. Johnson, M. C. Nelson, M. Standish
Sales Mgr.—R. D. Johnson also Pur. Agt.

***Minneapolis Plastic Molders, Inc.,** St. Paul, Minneapolis (*C, I, T*)
Compression Presses: 18 50 to 300 ton
Injection Machines: 3 4 to 8 oz.
Transfer Presses: 10 50 to 300 ton
Pres. & Treas.—J. Erick Anderson
Vice Pres.—E. W. Anderson

•*Minneapolis Plastics Corp., St. Paul (*I*)
Injection Machines: 32–4 oz. to 80 oz.
Pres.—H. R. Galloway
Vice Pres.—J. J. Brandt & C. S. Blackwell
Sales Mgr.—J. H. Thomas
Pur. Agt.—R. J. Busek

•*Northwest Plastics, Inc., St. Paul (*C, I*)
Compression Presses: 2–250 ton; 7–350 ton; 1–50 ton; 9–250 ton; 1–50 ton; 5–200 ton; 3–100–150 ton
Injection Machines: 6–8 oz.; 1–24 oz.; 1–2 oz.; 1–12 oz.
Pres.—J. R. Freyermuth
Vice Pres. & Chief Engineer—W. H. Mahle
Sales Mgr.—F. T. Thiets
Pur. Agt.—R. J. Twiss

---

* Operates own tool room.
• Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

***Plastics, Inc.**, St. Paul (*C, T*)
Compression Presses: 5–14 ton; 5–100 ton; 1–175 ton; 2–200 ton; 1–300 ton 2–500 ton
Transfer Presses: 1–175 ton; 1–300 ton; 2–500 ton
Pres.—H. A. Griebenow
Vice Pres.—P. K. Schilling
Sales Mgr.—P. K. Schilling
Secy. & Treas.—D. M. Munroe

Product Engineering & Development Co., Hopkins (*C, T*)
Compression Presses: 2–175 tons; 1–100 tons; 1–50 tons; 1–30 tons
Transfer Presses: 1–175 tons
Pres. W. E. Hutchins
Vice Pres., Sales Mgr. & Pur. Agt.—A. G. Morrison

***Rayette, Inc.**, St. Paul (*C, I*)
Compression Presses: 1–15 ton; 2–30 ton; 2–50 ton; 3–100 ton; 1–150 ton; 1–200 ton
Injection Machines: 2–8 oz.
Pres.—M. L. Arend
Vice Pres.—S. C. Watson, R. Whitman, W. P. Niemiec, Samuel Goodman
Treas. & Vice Pres.—J. V. Page
Pur. Agt.—W. C. Tuchfarber

***Sperzel Co.**, Minneapolis (*C, I, T*)
Compression Presses: 4–1000 ton; 4–500 ton
Injection Machines: 4–12–16 oz. Reed
Transfer Presses: 3–500 ton
Pres. & Pur. Agt.—M. J. McCabe
V. Pres.—A. Deinard
Sales Mgr.—H. H. Reinhard

MISSOURI

Clear View Plastics Corp., Poplar Bluff (*I*)
Injection Machines: 2–12 oz.; 1–12/16 oz.; 1–16/20 oz.
Pres., Gen. Mgr. & Sales Mgr.—Raoy B. West
Vice Pres. & Pur. Agt.—Wilbur E. Schweitzer

Comey Plastics, St. Louis (*C*)
Compression Presses: 1–500 ton; 2–400 ton; 4–200 ton; 2–150 ton; 1–85 ton; 1–25 ton
Pres.—Joseph Esloge
Sales Mgr.—James C. Grindell

***KSH Plastics, Inc.**, High Ridge (*E*)
Extrusion Machines: 3–3", 2–2"
Pres. & Sales Mgr.—R. S. Hawes
Vice Pres. & Pur. Agt.—F. L. Hawes

***George A. Kelley**, Fredericktown (*E*)
Extrusion Machines: 3
Owner—George A. Kelley

***Koch Manufacturing Co.**, Jackson (*C, T*)
Compression Presses: 3–75 ton; 2–100 ton; 2–170 ton; 1–250 ton; 2–400 ton; 1–500 ton
Transfer Presses: 2–75 ton; 2–170 ton; 1–250 ton
Pres.—J. Norbert Koch
Vice. Pres.—H. S. Courson
Sales Mgr.—H. R. Koch
Pur. Agt.—Winford Brown
Secy.—Robert M. Buerkle

Koller Craft Plastic Products, Inc., Fenton (*C, I, T*)
Compression Presses: 2–50 ton; 2–100 ton; 2–200 ton; 4–150 ton; 2–250 ton; 1–300 ton
Injection Machines: 1–2 oz.; 3–4 oz.; 1–9 oz.; 1–12 oz.; 2–16 oz.; 1–32 oz.; 2–100 oz.; 2–200 oz.
Transfer Presses: 2–150 ton; 2–200 ton
Pres. & Sls. Mgr.—Alois J. Koller
Vice Pres.—Robert A. Karasek
Pur. Agt.—Ralph Boehner

Kopplin Molding Corp., St. Louis (*C, I, T*)
Compression Presses: 3–75 ton; 3–100 ton; 1–150 ton; 1–200 ton
Injection Machines: 2–4 oz.; 1–5 oz.; 1–6 oz.; 1–12 oz.
Transfer Presses: 1–100 ton; 1–200 ton

***Kuhlman Plastics Co., Inc.**, Kansas City (*I*)
Injection Machines: 1–4 oz.; 1–9 oz.; 2–12 oz.; 4–16 oz.; 1–20 oz.; 2–48 oz.; 1–60 oz.
Pres.—Mr. O. E. Kuhlman
Sales Mgr. & Pur. Agt.—Mr. O. E. Kuhlman

***Lenco, Inc.**, Jackson (*C, T*)
Compression Presses: 1–75 ton; 1–100 ton; 1–200 ton
Transfer Presses: 1–200 ton
Pres.—Paul J. Leonard
Vice Pres.—W. C. Martinson
Sales Mgr. & Pur. Agt.—A. E. Perrin

●*National Plastic Products Co., Odenton, Maryland (*I, E*)
Injection Machines and Extrusion Machines:
Pres.—E. Winer
Vice Pres.—A. Winer
Sales Mgr.—J. R. Brown
Pur. Agt.—D. J. Anderson

●*Regal Plastic Co., Kansas City (*C*)
Compression Presses: 2–110 ton; Erie Presses, 1–40 x 50 platen W/To" Daylight 1–36 x 48 platen W/To" Daylight
Pres., Chairman of Board of Directors—J. S. Kivett
Vice Pres., Chief Engineer—N. D. Gallagher
Sales Mgr.—J. S. Kivett
Pur. Agent—Paul E. Snow

St. Louis Plastic Moulding Co., St. Louis (*C, I*)
Compression Presses: 2
Injection Machines: 6
Pres.—G. A. Goessling
V. Pres.—V. J. Goessling
Pur. Agt.—L. R. Sappington

NEBRASKA

***Kerr, R. W., Plastic Co.**, Hastings (*C, I, T*)
Compression Presses: 7 30–200
Injection Machines: 2 2–4 oz.
Transfer Presses: 2
Pres.—R. W. Kerr
Vice Pres.—Charlotte Kerr

***Kerrco Products**, Lincoln (*C, I, T*)
Compression Presses: 5–50–200 ton, 24" x 24"
Injection Machines: 1–4 oz.
Transfer Presses: 2
Pres.—R. W. Kerr
Sales Mgr.—D. W. Hemphill

Nebraska Plastics, Inc., Cozad (*E*)
Extrusion Machines: 1–3½"; 1–2½"
Pres.—Mrs. Milo V. German
Vice Pres. & Sales Mgr.—Mr. Dean Winegar
Pur. Agt.—Mr. Robert Hime

Omaha Plastics Co., Omaha (*C, I, T*)
Compression Presses: 4–25 ton; –325 ton
Injection Machines: 2–1 oz.; –4 oz.
Transfer Presses: 1–350 ton
Pres. & Pur. Agt.—George D. Kahn
Vice Pres.—Jewel K. Kahn

***Western Plastics Corp.**, Hastings (*E*)
Extrusion Machines: 8 Extruders, 1" through 3½"
Pres. & Treas.—John J. Lainson
V. Pres. & Sales Mgr.—Thomas J. Kreiner
Pur. Agt.—Keith W. Nielson

NEW HAMPSHIRE

●*Great American Plastics Co., Nashua (*I, E*)
Injection Machines: Average 40
Extrusion Machines: 10
Pres.—Irwin Cohn
V. Pres.—Melvin Rosensaft
Sales Mgr.—Charles Sussman
Pur. Agt.—Melvin Goldschine

●*Lamex Chemical Corp., Manchester (*I, E*)
Injection Machines: 10
Extrusion Machines: 12
Pres.—Joseph C. Foster
Vice Presidents: Abraham Goodman, Jack Goodman
Gen. Mgr.—George E. Pickering
Pur. Agt.—Charles Loiselle

NEW JERSEY

Alpha Plastics, Inc., Livingston (*E*)
Extrusion Machines: 2/2"–3"/2"–4"/2"
Pres.—C. E. Harkrader
Vice Pres. & Sales Mgr.—T. F. Long
Pur. Agt.—C. W. Oswald

***Atlas Plastics, Inc.**, Little Ferry (*I*)
Injection Machines: 3–12 oz.
Pres.—B. Maute

Bel-Art Products, West New York (*I*)
Injection Machines: 1–4 oz.
Pres.—K. Lansberger
Vice Pres.—Geo. McClure

Berkeley Engineering & Mfg., Co., Berkeley Hts. (*C, I*)
Compression Presses: 1–50 ton; 1–150 ton
Injection Machines: 1–16 oz.; 1–8 oz.; 2–4 oz.
Partners: Alfred F. Bahlke, General Manager & Engineer and William Giese, Factory Supt.

***Bloomfield Molding**, Bloomfield (*C, I*)
Compression Presses: 8–2–300 ton, 3–200 ton; 3–100 ton
Injection Machines: 2–4 oz.; 1–6 oz.; 2–9 oz.; 3–16 oz.; 1–2 oz.
Pres.—Sam Novick
Sales Mgr.—Jack Wegard
Pur. Agt.—Jules L. Verner

●Boonton Molding Co., Boonton (*C, I, T*)
Compression Presses: 96 presses, 25 to 500 ton
Injection Machines: 19 machines, ½ oz. to 20 oz.
Transfer Presses: 17 presses, 25 to 300 ton.

---

*Operates own tool room.
●Indicates Advertiser.

Letters indicate type of molding. (See p. 1074)

Gen. Mgr.—George K. Scribner
Plant Mgr.—Paul W. Dixon, Jr.
Sls. Mgr.—(Custom Molding)—Chis J. Groos
Sls. Mgr.—(Tableware)—William T. Stopford
Pur. Agt.—Henry Packer

***Celluplastic Corp.**, Newark (*I, E*)
Injection Machines: 15 3 oz.–6 oz.
Extrusion Machines: 5 2-½"–3-½"
Pres. & Treas.—J. D. Giles
Vice Pres.—A. Nichols
Vice Pres. Sales —J. D. Proctor

●*Clifton Hydraulic Press Co., Clifton (*C, I, T*)
Compression Presses: 8 up to 30 x 30–300 tons
Injection Machines: 4–2½ oz. to 4 oz.

●*Davis, Joseph, Plastics Co., Arlington (*I, E*)
Injection Machines: 13–2–16 oz.
Extrusion Machines: 25–1"–8"
Pres.—Morton Davis
Vice Pres.—Abraham Davis
Sales Mgr.—Lincdn Stenhardt
Pur. Agt.—Sam Goldblott

●*Die Molding Corp., Canastota, N.Y. (*C, T*)
Compression Presses: 52–35 to 500 ton
Transfer Presses: 10–25 to 500 ton
Pres.—Donald H. Dew
Vice Pres.—C. E. Davies
Sales Mgr.—B. Jarvis Dew
Pur. Agt.—Leroy Brooks

●*Dillon Beck Mfg. Co., Hillside (*I*)
Injection Machines: 3–4 oz.; 4–8 oz.; 2–16 oz.
Pres.—J. Parke Logan
Vice Pres. & Production—R. R. Lowe
Vice Pres.—Charles B. Sanders
Pur. Agt.—R. C. Ellis

●*Eagle Tool & Machine Co., Hillside (*C, I*)
Compression Presses: 1–200 ton
Injection Machines: 1–6 oz.; 2–16 oz.
Pres. & Sales Mgr.—Ernest J. Csaszar
Vice Pres.—Albert B. Holzl
Pur. Agt.—George Spiegel

●Emeloid Co., Inc., Hillside (*I*)
Injection Machines: 1–2 oz.; 2–4 oz.; 2–6 oz.; 2–8 oz.; 1–12 oz.
Pres.—M. P. Leeds
Vice Pres.—J. S. Freundlich
Sales Mgr.—G. W. Emerson
Pur. Agt.—Mrs. Florence Headley

***Fortney Manufacturing Co., Inc.**, Newark (*I*)
Injection Machines: 1–4 oz.; 2–8 oz.; 1–12 oz.
Pres. & Sales Mgr.—Eugene L. Fortney
Pur. Agt.—Elias L. Egeth

***Garfield Manufacturing Co.**, Garfield (*C, T, CM*)
Compression Presses: 70 presses; 10–500 tons
Transfer Presses: 10 25–300 tons
Pres. & Gen. Mgr.—G. H. Howell
Vice Pres. & Ch.Engr.—L. R. Egg
Sales Mgr.—J. N. Campbell
Pur. Agt.—W. J. Stagg

***Garray Plastics Co., Inc.**, Kearny (*I*)
Injection Machines: 8
Pres. & Sales Mgr.—Joseph Charzewski

***Gibson Associates Incorp.**, Cranford (*I*)
Injection Machines: 1–4 oz.; 1–8 oz.; 11–12 oz.; 1–22 oz.
Pres.—Rosyal H. Gibson
Vice Pres.—Patricia Gibson
Sales Mgr.—W. M. Preston
Pur. Agt. & Gen. Office Mgr.—Anthony J. Grimaldi

***Greising Engineering Co.**, Runnemede (*C, I*)
Injection Machines: 1–2 oz.
Compression Presses: 11–½ ton to 100 ton
Proprietor—Al. Greising

Holstein, Lee, Injection Molding Co., Inc., Clifton (*I*)
Injection Machines: 2–12 oz.; 1–8 oz.
Pres. & Pur. Agt.—Lee Holstein
Vice Pres.—Selma Holstein
Sales Mgr.—Brad Holstein

●*Hyde Co., A. L., Grenloch (*I*)
Injection Machines: 2–200 oz.; 1–28 oz.; 1–24 oz.; 1–20 oz.; 1–16 oz.; 2–12 oz.; 1–8 oz.; 2–4 oz.; 1–2 oz.
Pres. & Sales Mgr.—A. S. Hyde
V. Pres.—C. L. Hyde
Pur. Agt.—A. L. Hyde

***Hydrawlik**, Roselle (*E*)
Extrusion Machines: 2 2–3¼"
Pres. & Sales Mgr.—George A. Brown
Vice Mgr.—Robert C. Brown
Pur. Agt.—M. M. Johnson

***Industrial Devices, Inc.**, Edgewater (*I*)
Injection Machines: 5 2½ oz.
Pres. N. Schnoll
Vice Pres. & Sales Mgr.—N. J. Seiden
Pur. Agt.—G. Mesnick

Industrial Plastic Co., Metuchen (*E*)
Extrusion Machines: 4 3¼ to 4½
Pres.—Edgar A. Baurer
Vice Pres.—Jack Schenkman
Sales Mgr.—Joseph Schenkman
Pur. Agt.—Edgar A. Baurer

***Jersey Plastic & Die Casting Co.**, Irvington (*C, I*)
Compression Presses: 10 from 50–800 tons
Injection Machines: 10 1–200 oz.

Kaye Plastics Corp., New Brunswick (*I*)
Injection Machines: 3–8 oz.
Pres.—S. Leon Kaye
Vice Pres.—Philip Kaye
Secy.—Betty G. Kaye
Supt.—John Bolor, Jr.

Kesich Mfg. Co., Inc., Pitman
Compression Presses: 1–150 ton
Injection Machines: 1–2 oz.
Pres.—Michael Kesich
Secy. & Treas.—R. P. Kesich

***Ketchpel Engineering Co.**, West Englewood (*C*)
Compression Presses: 20 15–20 ton
Pres.—Paul A. Ketchpel, Sr.
Vice Pres.—Paul A. Ketchpel, Jr.

●*Killion Tool & Mfg., Co., Verona (*E*)
Extrusion Machines: 2 2½ & 3½
Pres.—Fred T. Killion

●*Kuhn & Jacob Molding & Tool Co., Trenton (*C, I, T*)
Compression Presses: 6–25 ton; 3–35 ton; 16–50 ton; 9–65 ton; 16–100 ton; 2–20 ton; 2–32 ton
Injection Machines: 18–50 ton
Transfer Presses: 6–100 ton; 15–140 ton
Pres.—Eugene Jacob
Vice Pres.—Walter Jacob
Sales Mgr.—Walter Jacob, Jr.
Pur. Agt.—Michael King

●*Ler-El Co., Jersey City (*I*)
Injection Machines: 14 from 1 oz. to 20 oz.
Pres., Sales Mgr. & Pur. Agt.—Miss Lore E. Feiler
Vice Pres.—E. E. Angelica

***Luzerne Rubber Co.**, Trenton (*C, I, E*)
Compression Presses: 5–43"; 5–36"; 2–84"; 8–24"
Injection Machines: 1–5 oz.; 7 oz.
Extrusion Machines: 1–4½"
Pres.—Bruce Bedford, Sr.
Vice Pres.—Larry E. Case
Pur. Agt.—William Gummere, Jr.

M. C. I. Plastics Corp., Lakewood (*I*)
Injection Machines: 4 12–16 oz.; 1–8 oz.; 5–6 oz.
Pres.—Richard E. Hartvug
Vice Pres.—H. C. Savr
Sales Mgr.—Richard E. Hartvug
Pur. Agt.—T. X. Beach

●*Mack Molding Co., Wayne (*C, I, T, E*)
Compression Presses: 45 15 ton to 560 tons
Injection Machines: 67 ½ oz. to 560 oz.
Transfer Presses: 12 90 ton to 560 tons
Extrusion Machines: 2
Pres.—K. W. Macksey
Vice Pres.—J. McIntosh
Sales Mgr. & Sec.—S. I. Howell
Pur. Agt.—R. B. McIntosh, E. Smith
Treas.—D. S. Kendall, Sr.

Mira Plastics Co., Inc., Paterson (*I*)
Injection Machines: 2–8 oz.; 1–12 oz.
Pres., Treas. & Sales Mgr.—Anthony Miragliotta
Vice Pres.—Mary Miragliotta

Modern Molders Inc., Kenilworth (*I*)
Injection Machines: 5 4–16 oz.
Pres. & Sales Mgr.—Michael Lutz
Vice Pres.—Julius Keck
Pur Agt.—Charles G. Karross, Jr.

***Ormond Manufacturing Co., Inc.**, Union City (*E*)
Extrusion Machines: 40 to 70 tons
Pres.—David Robertson
Vice Pres.—Joseph Ormound
Sales Mgr.—B. Berke
Pur. Agt.—Fred. Silberman

Plastex Process Co., Maywood (*E*)
Extrusion Machines: 1–1¼"; 1–2½"

***Plastic Inlays Corp.**, Summit (*I*)
Injection Machines: 1–16 oz.; 3–4 oz.; 4–8 oz.
Pres.—James J. Larmour
Ass't Treas.—William F. Easton
Sales Mgr.—George E. Nettleton
Pur. Agt.—Charles B. Brown

●*Plastic Horizons, Inc., Paterson (*CM*)
Pres.—W. L. Leipoto
Vice Pres.—J. L. Kane
Sls. Mgr. & Sec. Treas.—M. Brown

***Plasticraft Manufacturing Co.**, Kearny (*I*)
Injection Machines: 3–12 oz.
Pres.—I. Siper
Vice Pres. & Mgr.—B. Siper
Pur. Agt. & Secy.—S. Siper

Plastylite Corp., North Plainfield, N. J. (*C, T, E*)
Compression Presses: 2–50 ton; 4–100 ton; 3–75 ton; 4–150 ton; 1–250 ton
Transfer Presses: 2–150 ton
Extrusion: 2–2½"
President—H. Weinraub
Vice Pres. & Sales Mgr.—R. J. Goldstein

●*Plura Plastics, Maplewood (*I*)
Injection Machines: 3–8 oz.; 1–2 oz.

---

* Operates own tool room.
● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

Pres. & Owner: Wilbert J. Gahm
Vice Pres.—L. Gahm
Sales Mgr.—W. J. Gahm
Pur. Agt.—J. Dixon

Poly Plastic Products, Inc., Paterson (*E*)
Extrusion Machines: 2–1–½"; 1–2½"; 1–3½"; 1–4½"
Pres. & Sales Mgr.—Joseph Esak
Vice Pres. & Pur. Agt.—Alfred A.Voskian

●***Pyro Plastics Corporation,** Union (*I*)
Injection Machines: 42—Ranging in size from 2 oz. to 12 oz.
Pres.—Wm. M. Lester
Vice Pres.—B. L. Lester
Sales Mgr. Proprietary—Marvin A. Elson, Custom—Paul Schaaf
Pur. Agt. Louis Lubars
Sales Mgr. Premiums—Martin Krone

Raybestos-Manhattan, Inc., Passaic (*C, I, T, E*)

***Reliance Plastic & Chemical Corp.,** Paterson (*E*)
Extrusion Machines: 2
Pres.—Fred Levine

***Resistoflex Corp.,** Roseland (*C, E*)
Nine–20 to 800 tons
Extrusion Machines: Fourteen, Ranging up to 6"
Pres.—Edgar S. Peierls
Exec. V. Pres.—J. M. Gentile
V. P. Sales—H. E. Krebs
Pur. Agt.—R. Atkins

***Shasta Mfg. Co.,** Berkeley Heights (*I*)
Injection Machines: 8 2 to 20 ounces
Gen. Mgr.—G. S. Sullivan

***Shaw Insulator Co.,** Irvington (*C, I, T*)
Compression Presses: 28, from 15 to 350 tons
Injection Machines: 8, from 2 to 20 ounces
Transfer Presses: 32, from 15 to 350 tons
Pres.—Frank H. Shaw
V. Pres. of Operations—Stanford H. Shaw
V. P. & Secy.—M. M. Stallman
Pur. Agt.—Frank P. Ashley

***Star Mfg. Inc.,** Little Ferry (*C, T*)
5 Compression Presses: 10 to 150 tons
Transfer Presses: 7 10 to 150 tons
Pres.—Frank Vecchiotte
V. Pres.—Vincent Vecchiotte, Jr.

***Sterling Plastics Co.,** Union (*I*)
Injection Machines: 17, 2 to 20 oz.
Pres.—Geo. J. Staab
Sales Mgr.—Chas. A. Cox
Pur. Agt.—F. E. Betz

***V. H. Swenson Co. Inc.,** Arlington (*I*)
Injection Machines: 4 4 oz.; 4–8 oz.
Pres.—V. H. Swenson
V. Pres.—G. I. Feeley
Sales Mgr.—G. Kaiser
Pur. Agt.—G. I. Feeley

Tech-Art Plastics Co., Morristown (*C, I, T*)
Compression Presses: 80; from 50 to 1000 ton
Injection Machines: 8; from 2 oz. to 20 oz.
Transfer Presses: 6; from 50 ton to 200 ton
Pres.—Sydney R. Miles
V. Pres.—Dr. Clinton Grove
V. P. & Treas.—Harold J. Cook, V. P. & Secy.—William J. Woodruff
Pur. Agt.—Michael Halabura

---

*Operates own tool room.
●Indicates Advertiser.

●**United States Gasket Co.,** Camden (*C, I, E*)
Compression Presses: 12 from 5 ton to 3000 ton
Injection Machines: 8 machines to 8 oz.
Extrusion Machines: 14 machines: to 3" capacity
Pres.—A. J. Mullen
V. Pres. & Chief Eng.—C. M. Hogson
Sales Mgr.—H. S. Stott
Pur. Agt.—Jos. Campbell

***Wagner Plastic Corp.,** West New York(*I*)
Injection Machines: Four; 2 oz. to 12 oz.
Pres.—Walter Wagner
Plant Mgr.—L. E. Myers

***Wiggins Plastic Molding Co.,** Clifton (*C, I, T*)
Compression Presses: 32 10 to 500 ton
Injection Machines: 6 1 to 12 oz.
Transfer Presses: 12 20 to 500 ton
Pres. & Pur. Agt.—A. J. Wiggins
V. Pres.—J. R. Pinkerton
Secy.—P. Rainone

***Wilpet & Tool & Mfg. Co.,** Kearney (*I*)
Injection Machines: 20–2 oz. to 48 oz.
Pres. & Sales Mgr.—William L. Niclaus
V. Pres.—Richard Niclaus
Plant Mgr.—Richard Niclaus

NEW YORK

●***Ace Plastic Co.,** Jamaica (*E*)
Extrusion Machines: 2–1"; 2–1½"; 3–½"; 2–3½" & 1–4½"
Partners: A. D. Seidman, George J. Seidman & Sidney Seidman
Sales Mgr.—Sidney Seidman
Pur. Agt.—Irving Steinberg

Ace Plastic Molding Corp., L. I. C. (*I*)
Injection Machine: (2) 8 oz.

American Cystoscope Makers, Inc., Bronx (*E*)
Extrusion Machines: 2"
Pres.—Frederick J. Wallace

***American Hard Rubber Co.,** New York (*CM*)
Pres.—V. T. Norton
Vice Pres. & Sales Mgr.—R. Reppert
Secy.—B. E. Pollak
Treas.—E. W. Kane
Pur. Agt.—L. V. Culver

***American Plasticraft Co.,** New York (*C, I*)
Compression Presses: 10
Injection Machines: 4
Partners: Leo Cooper, Frank Yablon

●***Anchor Plastics Co., Inc.,** Long Island City (*E*)
Extrusion Machines: 15
Pres.—Richard A. Fisch

●***Auburn Plastics, Inc.,** Auburn (*C, I, T, E*)
Compression Presses: 5–85 ton, 14–75 ton, 15–150 ton, 2–500 ton, 6–50 ton, 4–100 ton, 1–600 ton
Injection Machines: 1–1 oz., 1–4 oz., 14–8 oz., 3–22 oz.
Transfer Presses: 6–75 ton, 2–100 ton, 4–150 ton, 1–200 ton, 4–300 ton, 3–800 ton, 1–600 ton.
Extrusion Machines: 2–1½", 4–2½", 2–3½", 4–4½", 1–5"
Pres.—J. H. Woodruff
Vice Presidents—E. M. Woodruff, Douglas Woodruff, Jr.
Pur. Agt.—G. H. Johnson

Augusta Plastics, Inc., Bronx (*I*)
Injection Machines: 1–8 oz.; 2–12/16 oz., 2–12 oz.
Pres.—Stanley Sapery
Pur. Agt.—Murray Napel

Bernard Plastics Molding Corp., Long Island City (*I*)
Injection Machines: 3–16 oz.; 1–12 oz.; 1–8 oz.; 2–6 oz.; 1–2 oz.
Pres.—Bernard B. Levine
Secy.—Estelle Levine
Sales Mgr.—Bernard B. Levine
Pur. Agt.—Carl Haller

***Brickmor Manufacturing Corp.,** New York (*I*)
Injection Machines: 2–2 oz.; 2–4 oz.; 4–8 oz.; 4–16 oz.; 4–12 oz.
Pres. & Sales Mgr.—Herman Julian Brickman
Vice Pres.—Bert B. Brickman
Pur. Agt.—M. J. Cahn

***Brilhart Plastics Corp.,** Mineola (*C, I*)
Compression Presses: 1–125 ton; 5–50 ton; 1–50 ton; 1–40 ton; 5–30 ton; 6–20 ton; 1–10 ton
Pres.—J. M. F. Conrad
Vice Pres.—A. W. Cummings
Sales Mgr.—T. C. Ackerly
Pur. Agt.—W. Shea

Castle Plastics, Inc., New York (*C*)
Compression Presses: 3–150 ton; 1–75 ton
Pres. & Sales Mgr.—C. V. Flynn

●***Chili Plastics, Inc.,** N. Chili (*I*)
Injection Machines: 5 machines 4–8 oz. capacity 2–4–6 oz.; 2 8 oz.; 1 6 oz.
Pres. & Pur. Agt.—Alton Dailey
V. Pres.—S. Richard Lehman
Sales Mgr. & Treas.—Richard A. Lehman

●**Contour Extrusion Co.,** Mamaroneck (*E*)
Extrusion Machines: 6 machines up to 2½"
Owners: J. Dukess & H. Van Leeuwen

Cotton, C. R. & Co., Inc., Brooklyn (*I*)
Injection Machines: 7 machines 4 to 20 oz.
Pres.—Chester B. Cotton
Vice Pres.—Rayden B. Edwards
Sales Mgr.—George M. Blumenthal
Pur. Agt.—Royden B. Edwards

Cox Plastics Corp., Buffalo (*C*)
Compression Presses: 31 oz. to 300 tons
Pres. & Sales Mgr.—James V. Cox
Vice Pres.—H. M. Gosnell

Crellin Plastics Corp., Chatham (*I*)
Injection Machines: 2–2 oz.; 3–8 oz.; 2–16 oz.; 1–20 oz.
Pres.—John R. Crellin, Sr.
Vice Pres. & Pur. Agt.—John R. Crellin, Jr.
Sales Mgr. & Secy & Treas.—Richard S. Crellin

Debo, L. F., Mfg. Co., Depew (*I*)
Injection Machines: 2–2 oz.; 1–4 oz.
Pres.—Leroy Debo
Vice Pres.—Florence Debo

●***Die Molding Corp.,** Canastota (*C, T*)
Compression Presses: 52–35 to 500
Transfer Presses: 10–25 to 500 ton
Pres.—Donald H. Dew
V. Pres.—C. E. Davies
Sales Mgr.—B. Jarvis Dew
Pur. Agt.—Leroy Brooks

Du Verre, Inc., Buffalo (*CM*)
Pres.—J. R. Kelly
Sales Mgr.—T. F. Killeen
Pur. Agt.—Henry Hasbrouck

***DuBois Plastic Products, Inc.,** Buffalo (*I*)
Injection Machines: 1–1 oz.; 1–2 oz.; 1–5 oz.; 2–6 oz.; 13–8 oz.; 2–10 oz.; 2–16 oz.
Pres.—N. J. Taylor
Vice Pres.—W. F. Sterne
Vice Pres. & Gen. Mgr.—R. A. Bright
Secy.—C. R. Holzworth
Sales Mgr.—J. H. Ehrhardt
Treas.—J. Silbert
Pur. Agt. & Ass't. Gen. Mgr.—R. V. Shear

Eagle Plastic Corp., Long Island City (*C, I, T, E*)
Compression Presses: 35 50–350 tons
Injection Machines: 5–4½ oz.
Transfer Presses: 1–50 ton
Extrusion Machines: 1–3¼ oz.
Pres.—L. Ludwig
Vice Pres.—S. Kluger
Sales Mgr.—S. Atkin
Pur. Agt.—I. Sobol

Excel Plastic Mfg. Corp., New York (*I*)
Injection Machines: 1–16 oz.; 2–8 oz.; 1–6 oz.

Fiberoid Doll Products Corp., Bronx (*I*)
Injection Machines: 1–8, 1–12–16, 1–16
Pres. & Sales Mgr.—Melvin L. Maisel

***Gary Enterprises, Inc.,** Brooklyn (*I*)
Injection Machines: 2–8 oz.; 1–10 oz.; 2–12 x 16 oz.; 1–12 oz.; 2–16 oz.
Pres.—Rudolph B. Fritzhand
Vice Pres.—Max Fritzhand
Sales Mgr.—Melvin Printz
Pur. Agt.—R. B. Fritzhand

***Glass Laboratories, Inc.,** Brooklyn (*I, E*)
Injection Machines:
Extrusion Machines:
Pres.—Abraham Shanok
Vice Pres. & Sales Mgr.—Jesse P. Shanok
Pur. Agt.—Victor Shanok

***Greer Industries, Inc.,** Jamaica (*C*)
Compression Presses: 5
Pres.—Robert P. Lord
Vice Pres.—Rolf Merton
Pur. Agt.—Erwin Gross

***Gries Reproducer Corp.,** New Rochelle (*I*)
Injection Machines: 17 .08 oz.
Pres.—O. Gries
Vice Pres.—A. Ehbrecht
Sales Mgr.—Joseph Saks
Pur. Agt.—Robert Barlow

***Guild Molders, Inc.,** Armonk (*I*)
Injection Machines: 2 to 6 oz.
Pres.—Mannie LaBarbera
Sales Mgr.—Emil Davidson

●*Hopp Plastics, New York (*I*)
Injection Machines: 2–8 oz.
Pres.—Herman Hopp
Vice Pres.—Philip Hopp
Sales Mgr. & Pur. Agt.—George Hopp

Hydro Molding Co., Inc., Plattsburgh (*C, I, T*)
Compression Presses: 8–50 to 175 ton
Injection Machines: 11–2 to 8 oz.
Transfer Presses: 6–50 to 175 ton
Pres.—S. Levites
Vice Pres.—M. A. Rabin

●*Ideal Plastics Div., Ideal Toy Corp., Hollis (*I*)
Injection Machines: 8–3 oz.; 10–4 oz.; 30–8 oz.; 2–9 oz.; 14–12 oz.; 2–16 oz.; 9–20 oz.; 4–32 oz.; 2–48 oz.; 2–60 oz.
Pres.—D. Rosenstein
Vice Pres.—Lionel Weintraub
Treas. & Prod. Mgr.—A. M. Katz
Vice Pres. Plastic Sales—A. C. Manovill
Secy. & Ass't Treas.—J. Miller
Pur. Agt.—L. Hansburg

Injection Molding Corp., New York (*I*)
Injection Machines: 12–4 oz. to 32 oz.
Pres.—Daniel D. Whyte
Vice Pres. & Prod.—Stanley S. Whyte
Vice Pres. Engineer—Jerome J. Stern
Vice Pres. & Sales Mgr.—Nicholas Klein
Pur. Agt.—Jay Whyte

International Plastic, New York (*I, E*)
Injection Machines: 1–2 oz.; 1–8 oz.; 1–12 oz.
Extrusion Machines: 1–3"
Pres.—Morton M. Ross

●Insulation Manufacturing Co., Inc., Brooklyn (*C, T*)
Compression Presses: 50–15 ton to 450 ton
Transfer Presses: 5–22 ton to 450 ton
Pres.—Ethel L. Starke
Sec.—C. Newell Starke
Sls. Mgr.—Robert Starke
Pur. Agt.—Emil Steinberger

***Jodee Plastics Co.,** Brooklyn (*I, E*)
Injection Machines: 1–2 oz.; 1–2½ oz.; 2–8 oz.; 1–9 oz.; 2–12 oz.
Extrusion Machines: 1–2½"
Pres. & Pur. Agt.—J. D. Bugloine
Vice Pres., Sales Mgr., Prod. Engineer & Supt.—N. Meglino

Kwik-Mold Plastic Corp., New York (*I*)
Injection Machines: 2–16 oz.; 2–8 oz.; 1–12 oz.; 1–4 oz.; 1–2½ oz.
Pres., Sales Mgr. & Pur. Agt.—Joseph Pearlman
Secy. & Vice Pres.—Sidney Salwen
Treas.—Murray Salwen

●Leaf Plastics, Inc., Yonkers (*I*)
Injection Machines: 2–4 oz; 2–8 oz.; 1–10 oz.; 2–12 oz.; 1–16 oz.; 1–20 oz. Total 9
Pres. & Pur. Agt.—George W. Leaf
Sec. & Treas.—Dr. Wm. Leaf
Sls. Mgr.—Lester Gabriel

***Majestic Molded Prod., Inc.,** Bronx (*I*)
Injection Machines: 20 4 to 200 oz.
Pres. & Treas.—H. Wish
Vice Pres. & Gen. Mgr.—N. R. Davis
Vice Pres. & Pur. Agt.—D. Sacharoff
Sales Mgr.—I. Sacharoff

Mastro Plastics Corp., New York (*I, E*)
Injection Machines: 24–4 oz. to 22 oz.
Extrusion Machines: 1

***Molded Industrial Plastics, Inc.,** Whitestone (*I*)
Injection Machines: 2 oz.; 6 oz.; 9 oz.; 16 oz.
Pres. & Sales Mgr.—P. I. Allen

Molding Corporation of America, New York (*I*)
Injection Machines: 2–8 oz.; 1–12 oz.
Pres., Sales Mgr. & Pur. Agt.—Robert M. Joffe
Vice Pres.—Anne Joffe

●*Norton Laboratories, Inc., Lockport (*C, I, T*)
Compression Presses: 45 75 ton to 450 ton
Injection Machines: 14 2 oz. to 16 oz.
Transfer Presses: 15 100 ton to 300 tons
Pres.—James B. Neal
Vice Pres., Factory Mgr. & Pur. Agt.—Milton L. Seekins
Sales Mgr.—Jack S. Dabbs

***P & H Enterprises,** New York (*I*)
Injection Machines: 1–2 oz.
Partners—James Hammond, John Paterson
Sales Mgr.—James Hammond
Pur. Agt.—John Paterson

***Plastiline, Inc.,** White Plains (*I*)
Injection Machines: 1–6 oz.; 2–8 oz.; 1–10 oz.; 1–12 oz.; 1–16 oz.
Pres.—Bryce N. Batler
Sales Mgr.—M. Hon. A. Batler
Pur. Agt.—Gerald Quinn

***Poly-Cell Plastics Co.,** Smithtown (*E*)
Extrusion Machines: 4 extruders
Pres. & Sales Mgr.—Joseph H. Rosenberg
Vice Pres.—Ross Rosenberg
Pur. Agt.—Robert Kinney

***Progressive Plastics Mfg. Co.,** New York (*I*)
Injection Machines: 1–4 oz.; 5–8 oz.; 1–9 oz.; 4–12 oz.; 1–16 oz.
Owner: Harry Meklembourg
Pur. Agt.—Leo Spalter

***Robinson Plastics Corp.,** New York (*I*)
Injection Machines: 2–16 oz., 3–12 oz.
Pres.—Sol M. Robinson
V. Pres.—Irvin I. Rubin
Sales Mgr.—Myron Maibrunn
Pur. Agt.—Irwin H. Robinson

●*Rotuba Extruders, Inc., Brooklyn (*I, E*)
Injection Machines: 4
Extrusion Machines: 9
Sales Mgr. Special Products—R. L. Boyse

Shoe Form Co., Inc., Auburn (*E*)
Extrusion Machines: 3½" National Extruder
Pres.—Frank P. DeWitt
Sales Mgr.—Gordon N. Tutton
Pur. Agt.—David E. Gregory

Specialty Insulation Mfg. Co., Hoosick Falls (*C, T*)
Compression Presses: 32–6"; 23–6"; 15–10"; 11 12"; 3 15"; 2 21"
Transfer Presses: 4–8"; 2 10"; 5 12"
Pres., Treas. & Sales Mgr.—E. J. Skorupski
Vice Pres.—H. H. Rice
Pur. Agt. & Secy.—C. J. Kempf

Starlite Plastic Co., Kenmore (*C*)
Compression Presses: 3–75 ton; 1–65 ton
Pres.—A. Bonk
Vice Pres.—S. Bonk
Sales Mgr.—S. Weir
Pur. Agt.—S. Weir

Streamline Plastics Co., New York (*I, E*)
Injection Machines: 7 machines: 4–8 oz.; 1–4 oz.; 2–2 oz.
Extrusion Machines: 5–2½"
Partners: Sol Bartner; Ed. Schlussel; Morton Schlussel; M. J. Schlussel

***Syracuse Ornamental Co. Inc.,** Syracuse (*C*)
Compression Presses: 1–500 ton; 4–230 ton; 6–170 ton
Pres.—A. E. Holstein
V. Pres.—P. M. Holstein
Sales Mgr.—R. A. Holstein
Pur. Agt.—M. F. Clark

---

*Operates own tool room.
●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123–1149

Syracuse Plastic Molders, Syracuse (*I*)
Injection Machines: 1–4 oz.; 1–8 oz.
Pres.—Joseph R. Falcone
V. Pres.—Anthony Falcone, Jr.

***Thermold Corp.,** Manlius (*I*)
Injection Machines: 1–12 oz.; 1–9 oz.; 1–2 oz. Automatic; 1–6 oz.
Pres.—Herbert A. T. Smith
V. Pres. & Sales Mgr.—Wallace B. Ross
Pur. Agt.—Huntington Ethridge, Jr.

***Tico Plastics, Inc.,** New York (*I*)
Injection Machines: 3–16 oz.; 6–8 oz.
Pres. & Sales Mgr.—Saul Blitz
V. Pres.—I. S. Kirstein
Pur. Agt.—Charles E. Cohen

***Tri-Point Plastics, Inc.,** Albertson, L. I. (New York) (*E*)
Extrusion Machines: 7
Pres. & Chief Eng.—Sol Mulay
V. Pres. & Treas.—Jack Kipnes
Sales. Mgr.—Pat Ruggieri & Advt. Mgr.
Pur. Agt.—Sid Kipnes

***United Mask & Nov. Co. Inc.,** Glendale, L.I., N.Y. (*C*)
Compression Presses: 1–75 ton
Pres.—Elwood Pamatat
V. Pres., Sales Mgr. & Pur. Agt.—Clinton Pamatat

Voges Manufacturing Co. Inc., Ozone Park (*I*)
Injection Machines: (2)–16 oz.; (1)–12 oz.; (2)–9 oz.; (1)–7 oz.; (1)–4 oz.; (1)–2 oz.

●***Vogt Mfg. Corp.,** Rochester (*E*)
Extrusion Machines: 10 up to 4½"
Pres.—L. S. Foulkes, Jr.
V. Pres., Mgr. & Sales Mgr. Plastic Div.—R. A. Lander, Jr.
Pur. Agt.—P. M. Ramsey

●**Waljohn Plastics, Inc.,** Brooklyn (*I, E*)
Injection Machines: 4
Extrusion Machines: 7
Pres.—Walter Bell
V. Pres.—John Novelo
Sales Mgr.—Herb. Weber
Pur. Agt. & Product Mgr.—M. Hershtal

***Westplex Corp.,** Rochester (*I*)
Injection Machines: 1–12 oz.; 2–10 oz.; 2–6 oz.; 2–2½ oz.
Pres. & Treas.—J. A. West, Jr.
V. Pres.—E. G. Ritter
Sales Mgr.—R. E. Lee

Whyte Mfg. Co., Inc., New York (*I*)
Injection Machines: 12–4 oz. to 32 oz.
Pres.—Daniel D. Whyte
V. Pres. Prod.—Stanley S. Whyte
V. Pres. & Eng.—Jerome J. Stern
V. Pres. & Sales Mgr.—Nicholas Klein
Pur. Agt.—Jay Whyte

***World Plastex,** New York (*I, E*)
Injection Machines: 1–16 oz.
Extrusion Machines: 2–3¼"; 1–2½"; 2–2"; 1–1½"
Partners: Milton Book; L. A. Cook; C. F. Hutcheon; George Streisguth
Partner and Sales Mgr.—E. B. Leimseider
Pur. Agt.—Milton Book

NORTH CAROLINA

***Burlington Molding Corp.,** Burlington (*C, I, T*)
Compression Presses: 1–200 ton; 1–50 ton; 1–15 ton
Injection Machines: 1–32 oz.; 2–20 oz.; 1–16 oz.; 1–3 oz.
Transfer Presses: 1–200 ton
Pres.—J. D. Strader
Executive Vice Pres. & Gen. Mgr.—D. M. Powers
Supt. of Molding—C. N. Cox

***Southern Plastics Engineering Corp.,** Greensboro (*C, I, T*)
Compression Presses: 1–20 ton; 1–50 ton; 1–100 ton; 1–350 ton
Injection Machines: 1–4 oz.; 1–8 oz.; 1–22 oz.
Transfer Presses: 1–100 ton

OHIO

Adams Plastic Products, Cincinnati (*I*)
Injection Machines: 2–8 oz.; 1–3 oz.; 1–36"
Pres.—Raymond N. Adams
Vice Pres.—Mary Doyle Adams
Sales Mgr. & Pur. Agt.—Wesley A. Weaver

●***American Agile Corp.,** Maple Hts. (*C, I, E*)
Custom Molders & Extruders: 1–48 x 72, 1–48 x 96
Injection Machines: 2–16 oz.; 1–160 oz.
Extrusion Machines: 3
Pres.—Dr. J. A. Neumann
Vice Pres. & Sales Mgr.—Mr. C. F. Freedman
Pur. Agt.—Mrs. L. W. Weidinger

Argo Plastic Products, Cleveland (*I, E*)
Injection Machines: (1) 16 oz.
Extrusion Machines: (1) 2–½"
Pres.—M. Axelrod
Vice Pres.—D. E. Grant
Sales Mgr.—J. Metz
Pur. Agt.—E. J. Kaiser

●**Barron, J. E., Plastics, Inc.,** Cincinnati, Ohio (*I*)
Injection Machines: 1–2½ oz.
Pres., Sales Mgr. & Pur. Agt.—J. E. Barron
Vice Pres.—T. B. Reynolds

Bluebird Plastics, Inc., Coshocton (*I*)
Injection Machines: 1–8 oz.; 1–12 oz.; 1–20 oz.
Pres.—W. D. Timmons, Sr.
Vice Pres.—R. K. Fox
Sales Mgr. and Gen. Mgr.—Edward B. Dennison
Pur. Agt.—Edward B. Dennison
Treas.—John B. Gerlach

***Campro Co.,** Canton (*I*)
Injection Machines: 13 machines 6 to 32 oz.
Pres.—Albert Harris
Vice Pres.—Charles Wolk
Sales Mgr.—Robert Sweaney
Pur. Agt.—E. Licklider

●**Carlon Products Corp.,** Cleveland (*E*)
Extrusion Machines: 30–2" to 10"
Pres.—Wm. L. Abromowitz
Vice Pres.—Philip S. Britton, Mr. Brigham Britton
V. P. & Gen. Mgr.—Walter S. Prendergast
Treas.—Donald E. Weaver
Prod. Mgr.—Rudolph Kustra

***Champion Molded Plastics, Inc.,** Bryan (*I*)
Injection Machines: 17–4 oz. to 60 oz.
Pres., Gen. Mgr. & Sales Mgr.—L. L. Phillips
Vice Pres.—George Hester
Pur. Agt.—J. C. Sloan

***Cincinnati Molding Co.,** Cincinnati (*C*)
Compression Presses: 6 to 75 tons

***Conneaut Rubber & Plastics Co.,** Conneaut (*E*)
Extrusion Machines: 6
Pres.—J. M. W. Chamberlain
Vice Pres.—R. C. Hunter
Sales Mgr.—J. H. Davison
Pur. Agt.—J. B. Phipps

***Cosmo Plastics Co.,** Cleveland (*I*)
Injection Machines: 3–8 oz., 3–12 oz.
Pres. & Pur. Agt.—I. Gordon
Vice Pres.—A. Gordon
Sales Mgr.—B. Gordon

D & G Plastics Co., Kent (*I*)
Injection Machines: 1–8 oz.; 1–10 oz.; 1–16 oz.
Partners: D. L. Davenport & Victor Gontero

***Dimco-Gray Co.,** Dayton (*C, T*)
Compression Presses: 17 from 5 to 400 tons
Transfer Presses: 3 from 60 to 140 tons
Managing Partner—F. E. Gray
Partners—R. K. Gray & J. D. Gray
Ass't Gen. Mgr.—R. A. Wright
Sales Mgr.—C. F. Dearth

***Dover Molded Products Co.,** Dover (*I*)
Injection Machines: 2–60 oz.; 32 oz.; 1–28 oz.; 1–29 oz.; 2–16 oz.; 2–12 oz.; 2–8 oz.; 1–4 oz.
Pres.—R. H. Freitag, Sr.
Gen. Mgr.—W. R. Gross
Pur. Agt.—R. W. Freitag

Elyria Molding & Eng. Co., Elyria (*C, I, T*)
Compression Presses: 4
Injection Machines: 1–8 oz.
Transfer Presses: 8
Pres., Sales Mgr. & Pur. Agt.—Rudolph Frey

***Fabri-Form Co.,** Byesville (*E*)
Extrusion Machines: 1–3½"
Pres.—J. W. Knight
Vice Pres.—R. L. Baker
Sales Mgr.—R. L. Baker
Pur. Agt.—E. E. Wray

●***General Industries Co., Plastics Div.,** Elyria (*C, I, T*)
Compression Presses: 97 from 30 to 1800 ton
Injection Machines: 15 from 8 oz. to 200 oz.
Transfer Presses: 29 from 100 to 425 ton
Pres.—Wm. E. Foster
Chairman of Bd.—A. W. Fritzche
Vice Pres.—O. W. Marsh
Sales Mgr.—J. M. Callihan
Pur. Agt.—C. Heidrich

●***General Tire & Rubber Co.,** Akron (*E*)
Extrusion Machines: up to and including 3"
Pres.—William O'Neil
Vice Pres.—L. A. McQueen
Pur. Agt.—D. A. Kepler

***Glastic Corp.,** Cleveland (*C*)
Compression Presses: 4

Globe Molded Plastics Co., Byesville (*I*)
Injection Machines: 2–18 oz.
Pres.—Verland Frederick
Vice Pres.—Lewis Matheny
Secy., Treas. & Sales Mgr.—A. T. Gander
Plant Mgr.—William Long

Johnson Plastic Corp., Chagrin Falls (*I, E*)
Injection Machines: 7 8–16 oz.
Extrusion Machines: 12 2½" to 4½"
Pres.—W. F. Miller, Sr.
Vice Pres.—Smith Johnson

*Operates own tool room.
●Indicates Advertiser.

Sales Mgr. & Gen. Mgr.—W. F. Miller, Jr.
Plant Mgr.—F. P. Kelly
Pur. Agt.—E. A. Richardson

●* **Kurz-Kash, Inc.**, Dayton (*C*)
Compression Presses: 130-10 to 800 ton
Pres.—W. G. Davidson
Vice Pres.—R. L. Davidson, F. R. Kiernan
Sales Mgr.—R. L. Davidson
Pur. Agt.—I. H. Naas

* **L & P Tool Co.**, Cincinnati (*E*)
Extrusion Machines: 1-1½"

Lake Erie Plastics Co., Elyria (*I*)
Injection Machines: 2-8 oz.; 1-10 oz.; 1-16 oz.
Owner—O. F. Everitt
Plant Supt.—W. L. Wacker

● **Lincoln Molded Plastics, Inc.**, Circleville (*I, E*)
Injection Machines: 22 3 oz. to 200 oz.
Extrusion Machines: 2
Pres.—H. M. Jenkins
Vice Pres., Mfr. & Sales—M. W. Burkhart
Ass't Sales Mgr.—D. E. Meyers
Secy. & Treas.—James Goodman
Ass't Secy. & Treas.—E. C. Jankura

Majestic Molding Co., Elyria (*I*)
Injection Machines: 1-4 oz.; 4-8 oz.; 2-16 oz.
Pres.—W. T. Kahliff

Manufacturer's Corp., Mansfield (*E*)
Extrusion Machines: 4 1-2½; 2-3½; 1-4½
Pres.—G. E. Leadbetter
Vice Pres.—William E. Heichel
Sales Mgr.—T. M. Dailey

* **Meridian Plastics, Inc.**, Byesville (*I, E*)
Injection Machines: 2-4 oz.; 1-9 oz.; 4-16 oz.; 1-20 oz.
Extrusion Machines: 1-¾"
Pres. & Treas.—J. E. Wolfe
Vice Pres.—James Hoag, J. F. Jaeger
Sales Mgr.—Robert W. Weil, J. K. Morisey
Sales Mgr. Plastic Wall Tile Div.—Robert W. Weil
Pur. Agt.—E. M. Brown also Ass't Treas.

* **Metal Specialty Co.**, Cincinnati (*I*)
Injection Machines: 1-1½ oz., 2-4 oz.; 1-16 oz.; 3-48 oz.
Pres.—Mr. Arnold Tietig III
Vice Pres. & Gen. Mgr.—Mr. Harvey Johnson
Vice Pres. & Sales Mgr.—Mr. Gordon P. Reif
Vice Pres.—Mr. Joseph Stross

Mold Rite Plastics, Inc., Cambridge (*C, T*)
Compression Presses: 30-300 ton
Transfer Presses: 50-200 ton
Pres.—LeRay F. James
Secy. & Treas.—Ronald L. James

Peerless Molded Plastics, Inc., Toledo (*C, I, T*)
Compression Presses: 35 from 25 to 300 ton
Injection Machines: 12-2 oz. to 12 oz.
Transfer Presses: 8-75 to 200 ton
Pres. & Treas.—W. G. Skutch
Vice Pres.—W. G. Skutch, Jr., R. E. Wagner
Sales Mgr.—W. G. Skutch, Jr.
Pur. Agt.—J. Tockermann

* **Pioneer Plastics**, Dayton (*I*)
Injection Machines: 4 1 to 4 oz.
Owner & Mgr.—William T. Strom

Plaskolite, Inc., Columbus (*E*)
Extrusion Machines: 5 2-2"; 2-2½"; 1-3½"

●* **Plastex Co.**, Columbus (*E*)
Extrusion Machines: 9 2½" to 4½"
Pres.—R. S. Zimmerman
Vice Pres.—R. O. Zimmerman
Exec. V. P.—P. M. Rhulman
Sales Mgr., Pipe Div.—R. L. Shannon
Custom Div.—R. P. Slatter
Pur. Agt.—P. M. Rhulman

* **Plastic Moldings Corp.**, Cincinnati (*C, I*)
Compression Presses: 72 up to 400 tons
Injection Machines: 1-4 oz.
Pres.—Edwin H. Gerdes
Vice Pres.—J. E. Bast
Sales Mgr.—Robert W. Gerdes
Purchasing Agt.—Edwin J. Gerdes

Plastic Products Corporation, Bedford Heights (*C*)
Compression Presses: 2-25 ton; 2-50 ton; 2-100 ton
Pres.—S. B. Knight
Vice Pres. & Secy.—Earl P. Schneider
Sales Mgr.—Arthur B. Robinson
Pur. Agt.—Charles B. Clark, Jr.

* **Plastic Toys Corporation**, Byesville (*I*)
Injection Machines: 1-4 oz. Lewis; 1-2 oz.
Pres.—O. J. Sharpe
Vice Pres.—D. Gregory
Sales Mgr.—O. J. Sharpe
Pur. Agt.—D. Gregory

●* **Plastic Research Products**, Urbana (*C, T*)
Compression Presses: 35 20 to 850 tons
Transfer Presses: 15 50 to 350 tons
Pres.—Warren G. Grimes
Vice Pres.—Donald O. Printz
Sales Mgr.—Richard E. Stockton
Plant Mgr.—E. R. Finley
Chief Engr.—L. L. Lyon

Precision Molded Plastics, Inc., Cleveland (*I*)
Injection Machines: 4-8 oz. to 22 oz.
Pres.—C. C. Gildersleeve
Vice Pres.—M. M. Gildersleeve

R. & K Tool & Die Co., Cleveland (*I*)
Injection Machines: 6-4 oz.; 2-8 oz.; 1-12 oz.; 1-16 oz.
President—John A. Rybak
Vice Pres.—Fred R. Krevscher
Sales Mgr. R. A. Rybak
Pur. Agt. Cloyd C. Herr

●* **Recto Molded Products, Inc.**, Cincinnati, (*C, I*)
Compression Presses: 57 7 ton to 300 ton
Injection Machines: 8 2-4 oz.; 3-8 oz.; 3-6 oz.
Pres.—N. A. Backscheider
Vice Pres.—Irwin H. Klein
Sales Mgr.—A. R. Rebold
Pur. Agt.—Lloyd S. Larrick

* **Sajar Plastics, Inc.**, Middlefield (*I*)
Injection Machines: (3) 8 oz.
Pres.—A. H. Radde
V. Pres.—L. M. Johnson
Sales Mgr.—P. D. Sanborn
Pur. Agt.—R. N. Hills

● **Seiberling Rubber Co., Plastics Div.**, Newcomerstown (*E*)
Extrusion Machines: 1-3½"—250 lbs./hr.
Pres.—J. P. Seiberling
V. Pres.—H. P. Schrank
Sales Mgr.—C. J. Figenscher (Plastics Div.)
Pur. Agt.—W. H. Oran

J. H Shepherd & Son & Co., Elyria (*I*)
Injection Machines: 2-8 oz. Machines
Partnership—Irving L. Shepherd and Ruth K. Shepherd

● **Standard Molding Corp.**, Dayton (*I*)
Injection Machines: 1-4 oz.; 2-8 oz.; 1-16 oz.; 1-28 oz.; 1-48 oz.
Pres.—W. F. Oelman
V. Pres.—M. E. Koch
Sales Mgr.—Richard E. Myers
Pur. Agt.—L. G. Webster

* **Sun Plastic Inc.**, Cuyahoga Falls (*I*)
Injection Machines: 1-4 oz.; 1-8 oz.; 1-10 oz.; 1-12 oz.
Pres. & Treas.—A. D. Grafton

Therm-O-Plastic Products, Urbana (*I*)
Injection Machines: 7-6-200 oz.
Pres., Sales Mgr. & Pur. Agt.—Hugh Hall
(1) V. Pres.—Roy Lyon
(2) V. Pres.—Roy Dye

Toledo Plastics Co., Toledo (*C, I*)
Compression Presses: 1
Injection Machines: 5

● **Vacuum Plastics Corp.**, Columbus (*E*)
Extrusion Machines: One (1) 2½"
Pres.—Herbert S. Cook
V. Pres.—Preston Davis
Pur. Agt.—Martin L. Grosh

●* **Van Dorn Iron Works Co.**, Cleveland (*I, E*)
Injection Machines: 3-8 oz.; 1-10 oz.; 2-12 oz.; 5-2½ oz.
Extrusion Machines: Hartig 3¼"; Windsor 2¼"; National Rubber 4½"
Pres.—L. C. Jones
V. Pres.—F. Sadler
Sales Mgr.—J. J. Reichel
Pur. Agt.—L. W. Curren

* **Vichek Tool Co.**, Cleveland (*C, I, E*)
Compression Presses: 1-150 ton; 1-250 ton; 1-400 ton
Injection Machines: 2-2 oz.; 1-3 oz.; 1-4 oz.; 1-5 oz.; 1-6 oz.; 1-9 oz.; 2-12 oz.; 2-24 oz.; 1-48 oz.
Extrusion Machines: 1-3½"
Pres. & Treas.—E. C. Koster
V. Pres.—L. F. Storie
Sales Mgr.—R. E. Imhoff
Pur. Agt.—F. J. Tkach

* **Welch Plastics & Mfg. Co.**, Columbus (*I*)
Injection Machines: Six from 4 to 12 oz. capacity
Pres. & Gen. Mgr.—Arthur R. Welch
V. Pres. & Sales Eng.—Ralph A. Welch

Wilson Plastics, Inc., Sandusky (*I*)
Injection Machines: 1-2 oz.; 1-4 oz.; 12-8 oz.
Pres.—O. C. Wilson
V. Pres. & Sales—J. L. Sampson
Sales Mgr.—J. L. Sampson
Pur. Agt.—W. W. Arnold

●* **Yardley Plastics Co.**, Columbus (*I, E*)
Injection Machines: 20
Extrusion Machines: 15
Pres.—F. B. Hill, Jr.
Vice Pres.—C. A. Ebner
Sales Mgr.—R. W. Rosel
Pur. Agt.—F. B. Hill, III

Zenith Plastics Company, Cleveland (*I*)
Injection Machines: 1-30 oz.; 1-24 oz.; 1-20 oz.; 1-16 oz.; 1-12 oz.; 1-9 oz.; 1-8 oz.; 2-4 oz.
Pres.—F. N. Acker

---

* Operates own tool room.
● Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

V.Pres. & Sales Mgr.—Paul R. Zurlinden
Pur. Agt.—Phyllis Keidel

OKLAHOMA

Continental Plastics, Oklahoma City (*I*)
Injection Machines: 2–16 oz.; 1–2½ oz.
Pres.—David De Lana
Vice Pres. & Gen. Mgr.—Ray Stroud
Sales Mgr.—Jack Davison
Pur. Agt.—Ray Stroud

OREGON

***Anderson Die & Mfg., Co.,** Portland (*I*)
Injection Machines: 1

***Beaman Plastics,** Portland (*C, I*)
Compression Presses: one 300 ton; 1 90 ton
Injection Machines: one 16 oz.
Pres.—Thelma E. Beaman
Vice Pres.—W. W. Hickman
Sales Mgr.—R. O. Morrison
Pur. Agt.—Ruth Goebel

***Grant & Roth Plastics, Inc.,** Portland (*C, I*)
Compression Presses: 1–300 ton
Injection Machines: 1–8 oz.; 3–4 oz.
Pres.—Dean L. Grant
Gen. Mgr.—Merrill R. Roth

PENNSYLVANIA

***A. S. K. Mfg., Co.,** Philadelphia (*I*)
Injection Machines: 4–1½ oz.; 2 oz.; 2–4 oz.; 4 oz.
Pres., Vice Pres., Sales Mgr., Pur. Agt.—Harry Vartanian

Allegheny Plastics, Inc., Coraopolis (*E*)
Extrusion Machines: 2

●***American Insulator Corp.,** New Freedom (*C, I, T, CM*)
Compression Presses: 85–10 to 200 tons
Injection Machines: 14–4 to 48 oz.
Transfer Presses: 16–40 to 650 tons
Pres.—E. J. Caughlin
Vice Pres.—B. Frank Hantz
Secy.—Ralph F. Fisher
Treas.—V. E. Hellrung
Pur. Agt.—A. L. Bortner

Applied Plastics, Erie (*C, I, T*)
Compression Presses: 1–500 ton; 6–300 ton; 2–400 ton; 1–250 ton; 2–200 ton; 1–150 ton; 2–75 ton
Injection Machines: 1–12 oz.
Transfer Presses: 2–400 ton; 3–300 ton; 2–200 ton; 1–250 ton; 1–150 ton
Pres.—M. H. Rowley
Vice Pres. & Gen. Mgr. Plastic Div.—Lloyd T. Moore

***Bruce Molded Plastic Prod.,** Pittsburgh (*C, I*)
Compression Presses: 1–150 ton; 1–300 ton
Injection Machines: 1–oz.; 2–12 oz.; 1–20–28 oz.; 1–12–16 oz.
Pres. & Sales Mgr.—L. F. Marks
Vice Pres. & Pur. Agt.—Leonard Louik

●***Byrd Plastics, Inc.,** Erie (*I*)
Injection Machines: 1–4 oz., 2–8 oz to 1–12 oz.
Pres.—Wm. R. Byrd
Sls. Mgr.—John Moon

***Calcon Mfg. Co., Inc.,** Washington (*E*)
Extrusion Machines: 2–3¼"; 1–6"; 2–4½"
Pres.—Joseph A. Morosco
Sales Mgr.—James C. Morosco
Pur. Agt.—A. W. Moore, Jr.

Child, S. G., Co., Phila. (*C, T*)
Compression Presses: 2–75 ton
Transfer Presses: 2–125 ton
Owner—Stanley G. Child, Jr.

Commonwealth Pipe & Tubing, Inc., Phila. (*I, E*)
Injection Machines: 1–1½ oz.; 1–2 oz.; 2–4 oz.
Extrusion Machines: 2–2½"
Pres., Sales Mgr. & Pur. Agt.—Harold B. Heft

●***Consolidated Molded Products Corp.,** Scranton (*C, I, T*)
Compression Presses: 52–15 to 500 ton
Injection Machines: 28–2 oz. to 60 oz.
Transfer Presses: 40–70 to 350 ton
Pres.—J. O'Connell
Vice Pres. & Supt.—E. W. Birney
Vice Pres. & Sales Mgr.—J. W. Pillinger
Secy.—J. E. McMahon
Pur. Agt.—Walter J. Golden

●***Curtiss-Wright Corp.,** Quehanna (*I*)
Injection Machines: 25–2 oz. to 48 oz.
Pres.—R. T. Hurley
Gen. Mgr.—Dr. K. F. Hager
Works Mgr.—S. R. Miccio

Curry Molding Laminating Co., Scranton (*C*)
Compression Presses: 1–37×38" 4 openings
Pres. & Sales Mgr.—Harry H. Rosenthal
Vice Pres. & Pur. Agt.—Kurt Adler

●***Erie Resistor Corp.,** Erie (*I*)
Injection Machines: 1–6 oz.; 6–8 oz.; 1–10 oz.; 3–12 oz.; 6–16 oz.; 3–32 oz.; 1–48 oz.; 2–60 oz.; 1–90 oz.; 1–120 oz.
Pres.—G. Richard Fryling
Vice Pres.—W. Henry Fryling, B. B. Minnihm, Allen K. Shenk, J. E. Dieteman
Sales Mgr.—W. C. Conroy
Pur. Agt.—George T. Griswold

***Franklin Plastics, Inc.,** Franklin (*I, E*)
Injection Machines: 1–22 oz.; 1–12 oz.; 1–8 oz.; 1–6 oz.
Extrusion Machines: 2–2½"; 3–3½"; 2–4½"
Pres.—Dixon P. Downey
Vice Pres.—Robert J. Litzinger
Sales Mgr.—B. E. (Jack) Tate
Pur. Agt. & Gen. Mgr.—R. T. Litzinger

Gessner Mfg. Co., Ambler (*C*)
Compression Presses: 8–15 to 110 ton
Partners: William, J. C. and Edward H. Gessner

●***H. & R. Industries,** Nazareth (*I, E*)
Injection Machines: 2–8 oz.
Extrusion Machines: 11–1¼" to 3½"
Pres.—J. J. Hauck
Vice Pres.—E. M. Roeder
Sales Mgr.—J. W. Simmons
Pur. Agt.—M. J. Getz

Halsey, Inc., Scranton (*C*)
Compression Presses: 2–15 ton; 4–200; 1–300
Pres., Sales Mgr. & Pur. Agt.—Halsey J. Sorrell
Vice Pres.—C. W. Hupfer

Insulation Products Co., Pittsburgh (*C*)
Compression Presses: 4–35 to 100 ton
Pres.—M. G. Rensland
Sales Mgr. & Pur. Agt.—H. A. Rensland

***Loranger Mfg. Corp.,** Warren (*C, T*)
Compression Presses: 4–15 ton; 2–50 ton; 2–75 ton; 1–100 ton; 9–200 ton; 1–700 ton
Transfer Presses: 4–200 ton; 1–300 ton
Pres.—J. Albert Loranger
Vice Pres. & Pur. Agt.—Arthur Loranger
Sales Mgr.—Howard M. Boyd

Ludascher, William C., Eddington (*I*)
Injection Machines: 1–4 oz.
Owner—William C. Ludascher

Mannesmann-Easton Plastic Products Co., Inc., Easton (*E*)
Extrusion Machines: 7–100; 2–65; 1–2
Pres.—Dr. Gerhard Wagner
Vice Pres.—W. F. Beunderman

***Molded Insulation Co.,** Phila. (*C, I, T*)
Compression Presses: 20–15 to 300 ton
Injection Machines: 16–1 to 46 oz.
Transfer Presses: 18–20 to 150 ton
Pres.—Wm. T. Bradbury
Vice Pres.—R. T. Hurst
Sales Mgr.—W. Bergler

Niagara Plastics Co., Inc., Erie (*I*)
Injection Machines: 2–4 oz.; 1–8 oz.; 1–16 oz.

***Nosco Plastics, Inc.,** Erie (*I*)
Injection Machines: 28 up to 200 oz.
Pres.—Mr. Harry Kugel
Vice Pres. & Sales Mgr.—Mr. Paul C. Rocke

●***Penn-Plastics Corp.,** Glenside (*C, I, T*)
Compression Presses: 15
Injection Machines: 5 from 2–20 oz.
Transfer Presses: 15
Pres.—J. T. Sullivan
Vice Pres. & Sales Mgr.—C. W. Kleiderer
Pur. Agt.—G. W. Wilson

●**Perry Plastics, Inc.,** Erie (*C, I, T, E*)
Compression Presses: 7–75 to 300 tons
Injection Machines: 13–4 oz. to 32 oz.
Transfer Presses: 4–200 to 300 tons/
Pres.—Jerry C. Stokes
Vice Pres. & Treas.—H. H. George
Sales Mgr.—S. C. Seley
Pur. Agt.—H. K. Diegmond

Plandex Corp., Downingtown (*E*)
Extrusion Machines: 2–3½"; 2–2.8"; 3–2" 1–2¾"

***Plastic Mold & Die Co.,** Darby (*C, I*)
Compression Presses: 1–60 ton
Injection Machine: 1–4 oz. Vert.

●***Polymer Corp.,** Reading (*E*)
Extrusion Machines: 10; 2 to 4½"
Pres.—Louis L. Stott
Sales Mgr.—Robert E. Barthold
Pur. Agt.—Paul T. Bordes

●***Polypenco, Inc.,** Reading, Pa. (*E*)
Extrusion Machines: 10; 2–4½"
Pres.—Louis L. Stott
Vice Pres.—Paul B. Handel, Jr.
Sales Mgr.—Horst M. Cleinow
Pur. Agt.—Paul T. Border

●**Port Erie Plastics Corp.,** Erie (*I*)
Pres.—H. J. Witkowski

●**Presque Isle Plastics, Inc.,** Erie (*I*)
Injection Machines: 3–4 oz.; 1–8 oz.; 1–12 oz.; 5–16 oz.; 1–22 oz.; 2–28 oz.; 1–32 oz.; 2–48 oz.; 1–90 oz.
Pres.—W. J. Phillips
Vice Pres.—C. J. Straub

●***Quinn-Berry Corporation,** Erie (*I*)
Injection Machines: 5–4 oz.; 1–6 oz.; 11–8 oz.; 4–12 oz.

---

*Operates own tool room.
●Indicates Advertiser.

Pres. and Sales Mgr.—James P. Quinn
Vice Pres., Mfg.—James P. Murphy
Sec'y. & Treas.—L. L. Berry
Asst. Secy.—E. M. Mulcahy
Pur. Agt.—A. P. Wagner

●*__Shaw Insulator Co.__, Stroudsburg, (*C, T*)
Compression Presses: 12 presses ranging from 15 to 350 tons
Transfer Presses: 12 presses ranging from 15 to 350 tons
Manager: John Lombardi

*__Skyline Industries, Skyline Plastic Pipe, Inc., Skyline Plastic Molding Inc.__, Titusville, (*C, I, E*)
Compression Presses: 1-100 ton; 1-200 ton; 6-1 ton
Injection Machines: 8-4 to 16 oz.
Extrusion Machines: 32-2½" to 12"
Pres.—Noel J. Poux
Vice Pres.—Richard J. Poux
Sales Mgr.—Raymond G. Gray
Pur. Agt. & Gen. Mgr.—Charles A. Poux

__Squires Plastics, Inc.__, Verona, (*C, T*)
Compression: 1-300 ton; 1-200 ton; 3-50 ton
Injection Machines: none
Transfer Presses: 1-300 ton; 1-200 ton
Pres. & Sales Mgr.—W. Kenneth Squires
Vice Pres.—W. A. Meyer
Superintendent—M. L. Worstell

__W. H. Stagg, Plastics Eng.__, Philadelphia, (*I*)
Injection Machines: 3-½ oz.; 2 oz.; 8 oz.
Owner & Pres.—Laura G. Stagg

●*__Sylvania Electric Products, Inc.__, Warren, (*C, I, T*)
Compression Presses: 43-15 ton to 150 ton
Injection Machines: 13-2 oz. to 48 oz.
Transfer Presses: 3-15 ton to 200 ton
Div. Gen. Mgr.—Marion E. Pettigrew
Div. Gen. Sales Mgr.—Philip M. Pritchard
Product Salesmanager, Plastics—Bruce E. Geddes
Div. Pur. Agt.—Kenneth F. Middaugh

*__Vulcanized Rubber & Plastic Co.__, Morrisville, (*C, I, T, E*)
Compression Presses: 94; from 14"×14" to 42"×48" Platens 50 ton; 616 ton
Injection Machines: 23; 3 oz.; 6 oz.; 8 oz.; 12 oz.; 16 oz.; 28 oz.; 50 oz.
Transfer Presses: (2) 150 to 200 ton; 30"×30" Platens
Extrusion Machines: 7; 1½" to 6"
Pres.—Robert G. Werner
Vice Pres. Mfg. & Sales—David Lewis
Vice Pres. & Treas.—A. O. Redland
Sales Mgr.—T. Earl Douglass
Industrial Div.—Philip E. Bauldry
Consumer Products Div.—Ira Dalrymple

*__Westlake Plastics Company__, Lenni Mills (*C, I, E*)
Compression Presses: 1-200 ton; 1-300 ton
Injection Machines: 1-#402 Stokes Automatic
Extrusion Machines: 4—1-1¼" N. R. M.; 1-2¼" N. R. M.; 2-3½" N. R. M.
Pres.—E. B. Westlake
Vice Pres.—E. F. Westlake
Sales Mgr.—W. F. Noonan, Jr.
Pur. Agt.—W. J. Grace

*__Westmoreland Plastics Co., Inc.__, Latrobe, (*C*)
Compression Presses: 21 total—18 automatics; 15 ton to 250 ton
Pres.—Glenn J. Davis
Vice Pres.—Eugene M. Schuman
Sales Mgr.—H. G. Skinner
Pur. Agt.—H. H. Jardine

*__A. H. Wirz, Inc.__, Chester (*C, I*)
Compression Presses: 1-50 to 150 tons
Injection Machines: 1-4 to 8 oz.
Pres.—Mark Dresden
Vice Pres.—Townsend Cox, Robert Cox & Walter Rowan
Sales Mgr.—Matthew Fox

*__Yates Company, Erie__ (*E*)
Extrusion Machines: 5-1" to 3½"
Pres.—R. N. Yates
Vice Pres.—J. O. Elbin
Sales Mgr.—W. N. Mulkie
Pur. Agt.—G. F. Woodford

RHODE ISLAND

__Anchorage Plastics, Inc.__, Warren (*C*)
Compression Presses: 50
Pres.—W. H. J. Dyer
Vice Pres. & Sales Mgr.—W. W. Chew
Pur. Agt.—Ogdon Mcagg

*__Cowan Boyden Corp.__, Providence (*I*)
Injection Machines: 3-8 oz.; 1-12 oz.; 1-16 oz.; 1-2 oz.; 1-20 oz.; 2-4 oz.
Pres., Treas. & Sales Mgr.—Clifton J. Cowan
Pur. Agt. & Asst. Treas.—Barbara G. Bottomley

*__Elkloid Co.__, Providence (*I*)
Injection Machines: 5-4-4 oz.; 1-8 oz.
Pres. & Sales Mgr.—J. Melvin
Vice Pres. & Pur. Agt.—Morris Baruch

__Greene Plastics Corp.__, Hope Valley (*C, I*)
Compression Presses: 10 to 100 ton
Injection Machines: 4 to 4 oz.
Pres.—G. W. Blunt White
Vice Pres. & Treas.—William Blunt White
Sales Mgr.—Walter F. Cole, Jr.
Pur. Agt.—Frank Card

*__Molding Corporation of America__, Providence (*C, T*)
Compression Presses: 24; 0-300 tons
Transfer Presses: 1-60 tons
Pres.—Mr. Robert G. Holt
Vice Pres.—Mr. Shirley Harrington
Sales Mgr.—Mr. Stephen Kalarian
Pur. Agt.—Mr. Sturgis Green

*__Plastic Engineering Co.__, Pawtucket, R. I. (*I*)
Injection Machines: 6-1 to 24 oz.
Pres., Sls. Mgr. & Pur. Agt.—Edward I. Rose
Vice Pres.—Beatrice Rose

●*__Tupper Corp.__, Woonsocket, (*I, E*)
Injection Machines
Extrusion Machines
Pres.—Earl S. Tupper

SOUTH CAROLINA

●__Mimosa Corp., Cardinal Div.__, Belton, S.C.
Injection Machines: 16-4 to 28 oz.
Pres.—Thos. J. Morton, Jr.,
Vice Pres.—M. B. Robbins
Sales Mgr.—W. H. Bailey

__Smoco Products Co.__, Hartsville, (*C, I, T, E*)
Compression Presses: 59-35 ton; 3-150 ton; 3-200 ton
Injection Machines: 1-16 oz.; 1-5 oz.
Transfer Presses: 1-150 ton; 1-300 ton; 1-500 ton
Extrusion Machines: 1-1½"
Pres.—J. L. Coker
Ex. Vice Pres.—C. W. Coker
Pur. Agt.—J. B. Boyd
V.P. In charge of Sales—C. H. Campbell

●*__Southern Plastics Co.__, Columbia, (*C, E*)
Compression Presses: 200 ton; 150 ton; 50 ton; 20 ton; 15 ton
Extrusion Machines: 3-3½"; 2-2½"
Pres.—J. W. Lindau
Vice Pres.—Irwil Kahn & Leonard Boges

TENNESSEE

__Kusan Incorporated__, Nashville (*I*)
Injection Machines: 5-12 oz.; 2-16 oz.; 2-32 oz.; 4-8 oz.; 1-4 oz.; 1-2 oz.;
Pres.—W. R. McLain
Vice Pres.—Earl Horton
Sales Mgr.—L. P. Brittain
Pur. Agt.—C. N. Shockley

__Morgan Plastics__, Nashville (*I*)
Injection Machines: 1-9 oz.
Gen. Mgr.—Wills N. Morgan
Sales Mgr.—E. S. Morgan, Jr.

*__National Plastics, Inc.__, Knoxville (*C, I*)
Compression Presses: 2-150 ton; 2-250 ton; 2-300 ton
Injection Machines: 1-1¼ oz.
Pres.—Chris Van Deventer, III
Vice Pres.—Charles L. Yeomans, M. T. Victor

*__Patent Button Co., of Tennessee, Inc.__, Knoxville (*C, I*)
Compression Presses: 48-15 ton; 50 ton
Injection Machines: 4; 4-12 oz.
Pres.—D. S. Hart
Vice Pres.—E. C. Snoddy
Sales Mgr.—D. G. Adcock
Pur. Agt.—S. E. Conningham

TEXAS

__Blackwell Plastic Molding Co., Inc.__, Houston (*I*)
Injection Machines: 6; 1-9 oz.; 1-8 oz.; 1-4 oz.; 1-3 oz.; 1-2¼ oz.; & 1 oz.
Pres. and Pur. Agt.—L. D. Blackwell
Vice Pres.—R. H. Blackwell
Sales Mgr.—Jim T. Pinkston

*__Crown Machine & Tool Co.__, Fort Worth (*I*)
Injection Machines: 20-4 oz. twin Moldmasters
Pres.—W. M. Harrison
Vice Pres.—James M. Harrison
Sales Agt.—Wm. Coughlen, Jr.
Pur. Agt.—E. L. Halvorson

__Linehan & Co.__, Dallas (*I, E*)
Injection Machines: 2-6 oz.; 1-8 oz.
Extrusion Machines: 4
Pres.—M. J. Linehan
Vice Pres.—J. B. Linehan
Sales Mgr. & Pur. Agt.—M. J. Linehan, Jr.

__Lone Star Plastics Co., Inc.__, Fort Worth (*C, I*)
Compression Presses: 1-12 ton; 1-20 ton; 2-30 ton; 1-200 ton
Injection Machines: 1-4 oz.
Pres.—Melvin Hare
Vice Pres.—E. H. Swazey

---

*Operates own tool room.
●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149.

Moore Plastics, San Antonio (*I*)
Injection Machines: 1–8 oz.
Owner—Bart Moore

***Nalle Plastics, Inc., Austin** (*I, E*)
Injection Machines: 2–8 oz.; 1–6 oz.; 2–3 oz.
Extrusion Machines: 1–2½"; 1–4½"
Pres.—George S. Nalle, Jr.
Vice Pres.—A. B. Nalle

Texas Plastic Products Co., Houston (*E*)
Extrusion Machines: 1–3½; 2–2½
Pres.—Thomas H. Shartle
Vice Pres.—A. B. Kelkley
Sales Mgr.—R. O. Tuxson
Pur. Agt.—C. M. Nettles
Secy. Treas.—C. M. Nettles

Wyatt's Plastics, Inc., Houston (*C, T*)
Compression Presses: 1–20 ton; 1–75 ton; 1–100 ton; 1–125 ton; 2–225 ton
Transfer Presses: 2–225 ton; 3–230 ton; 3–300 ton
Pres.—Walter B. Van Wart
Vice Pres.—J. I. Grant and C. J. Eckenrod
Sales Mgr. & Vice Pres.—R. L. Jarmon
Pur. Agt.—E. F. Foster

UTAH

***Rider Engineering & Plastic Co., Salt Lake** (*I*)
Injection Machines: 1–9 oz.; 1–4–6 oz.
Pres.—R. W. Rider
Vice Pres.—B. T. Rider
Pur. Agt. and Secy. M. W. Rider

VERMONT

Manchester Molding Co., Manchester (*I*)
Injection Machines: 8 oz.
Pres.—R. L. Thompson
Sales Mgr.—H. J. Stratton
Pur. Agt.—C. R. Ellingwood

***Newport Plastics Corp., Newport** (*CM*)
Pres.—J. R. Audet
Pur. Agt.—Paul Beatdry & Lloyd Douglas

VIRGINIA

***Hafleigh & Co., Buchanan** (*C, E*)
Compression Presses: 7–250 ton
Extrusion Machines: 2–42

***Hake Manufacturing Co., Inc., Roanoke** (*I*)
Injection Machines: 2–4 oz.; 6–8 oz.; 3–12 oz.
Pres.—George Kissak
Vice Pres.—Herman Buhles, Jr.
Sales Mgr.—Herman Buhles, Jr.
Pur. Agt.—Max Huss

Lurie Plastics, Inc., Colonial Heights (*I, E*)
Injection Machines: 1–3 oz.; 1–8 oz.; 1–16 oz.
Extrusion Machines: 1–4½"
Pres.—R. Lurie
Plant Mgr.—G. Finney
Coordinator—J. Coleman
Pur. Agt. & Chief Eng'r.—H. J. Schroeder

*Operates own tool room.
●Indicates Advertiser.

***Southeastern Plastics, Inc., Portsmouth** (*C, I*)
Compression Presses: 5–25 to 150 tons
Injection Machines: 2–4 to 12 oz.
Pres. & Sales Mgr.—Robert L. Davis
Vice Pres.—C. M. Davenport
Pur. Agt.—J. M. Harmon

***Universal Moulded Products Corp., Bristol** (*C*)
Compression Presses: 1–100 T. press, 18 × 18, 20" daylight; 3–120 T. presses, 32 × 32, 90" dl; 2–200 T. press, 24 × 30, 30" dl; 1–120 T. press, 60 × 72, 60" dl; 1–1500 T. press, 72 × 48, 28" dl
Pres.—Dr. Robert J. Nebesar
Pur. Agt.—J. G. Barnes

WASHINGTON

Allied Mfg., Co., Seattle (*C, I*)
Compression Presses: 2–300 ton
Injection Machines: 1–9 to 12 oz.
Pres.—C. A. Stone
Vice Pres. & Treas.—B. Wallace Rucker

***Pacific Plastics Co., Inc., Seattle** (*C*) (*CM*)
Compression Presses: 28 × 28–100 ton; 36 × 40–150 ton; 48 × 96–200 ton; 30 × 48–200 ton
Pres. & Sales Mgr.—Ben Rosen
Vice Pres.—Allen Rosen
Pur. Agt.—Bertha Seder

Western Plastics Corp., Tacoma (*E*)
Extrusion Machines: 2—1–3½; 1–4½
Pres.—James H. Wiborg
Vice Pres. & Sales Mgr.—Ralph L. Morgenthaler & Warren O. King
Pur. Agt.—Mrs. A. E. Skattum

WEST VIRGINIA

***Wheeling Stamping Company, Wheeling** (*C, I*)
Compression Presses: 11–50 T; 4–60 T; 2–100 T; 12–150 T; 1–250 T
Injection Machines: 1–½ oz.; 2–2 oz.; 1–3 oz.; 1–3½ oz.; 1–8 oz.
Pres.—A. W. Paull, Sr.
Sales Mgr.—Geo. A. Kraatz
Pur. Agt.—Lloyd B. Park

WISCONSIN

Chippewa Plastics, Inc., Chippewa (*I, E*)
Injection Machines: 1 only 1 oz.; 1 only 2 oz.; 2 only 6 oz.
Extrusion Machines: 1–1¼"; 15–1½"; 8–2½"; 1–3½"
Pres.—D. R. Williams
Vice Pres.—M. A. Williams
Sales Mgr.—R. G. Carson
Pur. Agt.—G. W. Dingman

Evans-Zeier Plastic Co., Madison (*I*)
Injection Machines: 2–8 oz.
Partners—D. L. Evans & R. C. Zeier

***Flambeau Plastics Corp., Baraboo** (*I*)
Injection Machines: 1–2 oz.; 1–4 oz.; 4–6 oz.; 2–8 oz.; 1–12 oz.; 1–20 oz.; 1–32 oz.
Pres. & Sales Mgr.—W. R. Sauey
Vice Pres.—N. O. Sauey
Pur. Agt.—R. C. Nowotny

Lewis, G. B. Co., Waterton (*C*)
Compression Presses: 8–50 to 250 tons
Pres.—G. Gordon Frater
Vice Pres. & Sales Mgr.—Milton A. Frater
Pur. Agt.—Arthur J. Killian

***Norco Plastics Inc., Milwaukee** (*C, I, T*)
Compression Presses: 11–1200 ton to 25 ton
Injection Machines: 5; 2–16 oz.; 2–9 oz.; 1–4 oz.
Transfer Presses: 4; 3–350 ton; 1–250 ton
Pres. & Pur. Agt.—Edward C. Berg
Vice Pres.—R. W. Hagemann
Sales Mgr.—Henry J. Berg

Peerless Mfg. & Distributing, Waukesha (*I*)
Injection Machines: 2–16 oz.; 1–9 oz.; 1–2 oz.
Pres.—H. A. Gantz
Vice Pres.—S. Wagner
Sales Mgr. & Pur. Agt.—T. K. Kellner

***Pereles Bros. Inc., Milwaukee** (*I*)
Injection Machines: 13
Pres. & Sales Mgr.—A. A. Pereles
Vice Pres. & Ass't. Sec.—D. M. Stern
Secy.—J. S. Pereles
Pur. Agt.—D. Baum

***Plymouth Industrial Products, Inc., Sheboygan** (*I*)
Injection Machines: 17 Capacity 60000 lbs./day, from 4 lbs. to 70 lb./capacity
Pres. & Sales Mgr.—A. J. Simmons
Vice Pres.—G. W. Mulder
Pur. Agt.—G. H. Abler

***Portz Plastics & Fibre Co., Milwaukee** (*C, I*)
Compression Presses: 2–100 ton; 1–200 ton
Injection Machines: 1–4 oz.; 2–8 oz.
Pres. & Pur. Agt.—Chas. A. Portz
Vice Pres.—Chas. Anthony
Sales Mgr.—R. Chop

***Presco Plastics, Milwaukee** (*I*)
Injection Machines: 4 oz. to 24 oz.
Pres. & Pur. Agt.—E. K. Schroeter
Manager—H. Schavf

●***Sunlite Plastics, Inc., Milwaukee** (*E*)
Extrusion Machines: One–1½"; Five–2½"; Two–3½"
Pres.—Robert G. Nelson
Vice Pres.—Eugene Slingluff

Trim Molded Products Co., Inc., Burlington (*I*)
Injection Machines: 1–8 oz.; 1–10 oz.; 2–12 oz.
Pres. & Treas.—Russell F. Hagen
Vice Pres.—Louis J. Robbers
Sales Mgr.—William Leslie
Secy. & Pur. Agt.—Jack Samuels

ENGLAND

●***Microcell, Ltd., Low Dow** (*C*)
Compression Presses: 20–25 tons to 3500 tons
Personnel: see p. 1094

GERMANY, WEST

●**Gebr. Battenfeld, Meinerzhagen** (*C, I, T*)
Compression Presses: 11 from 10 to 200 tons
Injection Machines: 18 from ¼ to 52 ozs.
Transfer Presses: 7 types 20 to 200 tons

CANADA

***Hathaway Kraemer Ltd., Kitchener, Ontario** (*I*)
Injection Machines: 1–4 oz.; 1–32 oz.; 1–8 oz.
Pres.—A. G. Hathaway
Vice Pres. & Pur. Agt.—James E. Kraemer

LAMINATORS

1—High Pressure
2—Molded Laminated
3—Plywood
4—Thermoplastic
A—Industrial
B—Decorative

Low Pressure and Contact (see Reinforced Plastics Processors, p. 1094)

ARIZONA

Royal Mfg. Co., Inc. Prescott
Specialize in: Blow Molding
Pres. & Sales Mgr.—C. C. Coates
V. Presidents—John D. Jackson & H. L. Berman
Pur. Agt.—E. C. Sturm

CALIFORNIA

Air Conductors, Compton (*2, 4, A*)
Max. size rolled tubing: 3/32 I D to 12" I. D.
Max. size molded tubing: 3/32 I.D. to 12" I D.
6" I D. x 10' Fibrous glass
Standard length tubing: 10 ft.
Specialize in: special purpose ducting, laminated tubing, air ducting
Personnel see p. 1094

Chemtron Fiber Glass Co. El Monte (*2, 3, 4, A, B*)
Max. size laminated tubing: 30" × 80"
Specialize in: custom-decorative
Pres.—R. L. Kinch
V. Pres:—C. L. Kuchinsky
Sales Mgr.—J. C. Larcom
Pur. Agt.—A. R. Kingsley

Crowl, Charles Company, El Monte (*1, 4, A, B*)

Gill, M. C. Corp. El Monte (*A, B*)
Max. size laminated sheet: 72" x 168"
Specialize in: flat sheet, Fibrous glass surfacing of plywood.
Personnel: see p. xx

Jet Specialties Co. Inc. Los Angeles (*4, A, B*)
Max. size laminated sheet: 52" wide and any length cut or coiled
Max. size rolled tubing: 1"OD
Standard length tubing: any size cut or coiled
Pres. & Gen. Mgr.—Lloyd W. Johnson
V. Pres. & Sls. Mgr.—Gerard H. Johnson
Comptroller, Pur. Agt. & Asst. to Pres.—Malcolm S. Haywood

Mica Corporation, Culver City (*1*)
Max. size laminated sheet: 48" x 96"
Decorative (Formica Type) Laminates
Pres. & Sales Mgr.—Robert T. Toppin
Secy. Treas.—A. Paul Goldman
Gen. Mgr.—Bernie Kessler
Pur. Agt.—Edward Kazarian

Parker Manufacturing Co. San Diego (*2, A, B*)
Max. size laminated sheet: Flat—42" × 144" maximum
Corrug. 40" × continuous
Specialize in: translucent Fibrous glass reinforced building panels
Pres. & Owner—Davis W. Parker
Sales Mgr.—Lydia S. Sleppy
Pur. Agt.—Harold C. Alexander (Raw materials

Plastic Age Sales, Inc. San Fernando (*1, 2, 4, A, B*)
Pres.—J. A. Kramer
Sales Co-ordinator—W. M. Commeford
Sales Mgr.—H. E. Renner
Pur. Agt.—Adolph Kramer

Reinhold Engineering & Plastics Co. Norwalk (*1, 2, A*)
Max. size laminated sheet: 4 ft. square
Max. size rolled tubing: Custom tubes to 10 ft. long
Standard length tubing: 3 ft.
Specialize in: low pressure & high pressure laminating and mat molding in the laminating division
Pres.—James P. Gruettner
V. Pres. & Pur. Agt.—H. J. Harris (Administration)
Sales Mgr.—William H. Barner

Rippolite Plastic Products, Inc. Burbank
Max. size laminated sheet: 40" × 12'
Pres. & Gen. Mgr.—Jack D. Whitehead
V. Pres. & Pur. Agt.—Leo J. Hulbert
Sales Mgr.—John C. Bixby

●**Swedlow Plastics Co.** Los Angeles (*1, A*)
Max. size laminated sheet: 5' × 10'
Pres.—Dave Swedlow
V. Pres.—John Endicott

Urrite Plastics Fabricators, Pico (*4, A*)
Pres., Owner, Sales Mgr. & Pur. Agt.—E. V. Steele

Wal-Mar Plastics, Inc. Torrance (*2, A*)
Pres.—Wallace J. De George
V. Pres.—Mark L. DeGeorge
Sales Mgr.—Ritson A. Ballinger
Pur. Agt.—John W. Burgess

CONNECTICUT

●**New England Laminates Co.** Stamford (*1, 2, A, B*)
Max. size laminated sheet: 40" x 80"
Specialize in: epoxy glass-copper clad
Pres.—John E. Currier
Sales Mgr.—Bruce B. Greenfield
Pur. Agt.—Mrs. Muriel Dillon

Plastic Film Corp. Plainfield (*4, A, B*)
Personnel: see p. 1076

Rowland Products, Inc. Kensington (*4*)
Max. size laminated sheet: 24" x 54"
Pres. & Treas.—Hugh Rowland
V. Pres.—William P. Rowland & Paul K. Rogers
V. P. Sales—Thomas D. Hogan
Pur. Agt.—Robert E. Randall

DELAWARE

●**Continental-Diamond Fibre Corp.** Newark. (*1, 2, A*)
Max. size laminated sheet 37" x 96"
Max. size laminated sheet 46" x 70"
Max. size rolled tubing: 56" ID x 58" OD
Max. size molded tubing: 9" ID x 9½" OD
Standard length tubing: 36" to 38"
Specialize in: All types Laminates-Phenolics-Melamine-Silicone-Epoxy-Polyester-Teflon
Pres., V. Pres. & Gen. Mgr.—H. K. Collins
V. Pres.—J. F. Anderson, E. O. Hausmann, F. M. Grauer
Director of Sales—H. M. Dexter
Gen. Sls. Mgr.—Arthur Briggs
Pur. Mgr.—W. H. Walker, Jr.

Franklin Fibre-Lamitex Corp., Wilmington (*1, 2, 4, A*)
Max. size laminated sheet: 36" x 36", 24" x 100"
Max. size rolled tubing: 25" OD
Max. size molded tubing: 4" OD
Standard length tubing: 36" Also 18", 48", 96"
Specialize in: punchings, stampings, screw machine work, special machining of sheets, rods, tubes

Haveg Industries, Inc. Wilmington (*2, 4, A, B*)
Max. size laminated sheet: 5" x 10'
Max. size rolled tubing: up to 10'
Max. size molded tubing: up to 10'
Standard length tubing 10'

●**National Vulcanized Fibre Co.** Wilmington (*1, A*)
Max. size laminated sheet: 39 x 47, 23 x 95
Max. size rolled tubing: 11½"
Max. size molded tubing: 11⅛"
Standard length tubing: 48"
Specialize in: vulcanized fiber industrial laminates
Pres.—E. R. Perry
V. Pres.—F. I. Crow
V. Pres. & Director of Sales—R. S. Fisher
Pur. Agt.—L. R. Clinton

ILLINOIS

●**Brunswick-Balke-Collender Co.,** Chicago (*1, 2, A*)
Specialize in: honeycomb form sandwich, solid laminate, "lost wax" preform. Structural aircraft components.
Pres.—B. E. Bensinger
Vice Pres.—S. E. Meyers
Sec.—G. H. White
Treas.—A. W. McMahon
Sls. Mgr. of Defense Contracts, Div.—A. N. Freeker, Ass't. to the Pres.
Pur. Agt.—E. F. Whittemore

● Indicates Advertiser.

●**Carroll, J. B. Co.** Chicago (*A, B, 4*)
Max. size laminated sheet 21" x 26"
Personnel: see p. 1103

Chicago Price Tag Mfg. Co. Chicago (*1*)
Max. size laminated sheet: 18" x 18"
Specialize in: printing on plastic sheet laminating.

Felsenthal, G. & Sons, Chicago (*1*)
Max. size laminated sheet: 20" x 25"
Pres. & Treas.—Ben W. Rau
V. Pres. & Sls. Mgr.—Earl R. Keown
Pur. Agt.—Burt Fredrickson
Vice Pres.—N. C. Ratner
Vice Pres.—J. H. Moses

●**Molded Products, Div. of Admiral Corp.,** W. Chicago (*1*)
Sales Mgr.—Raymond T. Leahy
Pur. Agt.—James J. Pellegrine

●**Plasticrafters, Inc.,** Chicago (*A*)
Specialize in: fibrous glass reinforced thermosetting plastics
Pres.—James A. Boyajian
V. Pres.—E. L. Boyajian
Sales Mgr.—Robert Jacobsen
Pur. Agt.—A. C. Tork

● **Richardson Co.** Melrose Park (*1, 2, A, B*)
Max. size laminated sheet: 48" x 144"
Max. size rolled tubing: 12" O. D.
Max. size molded tubing: 2" O. D.
Standard Length tubing: 36" to 48"
Specialize in: Nema & special grades of laminates for electrical & mechanical products, sheets, rods, tubes, and fabricated parts. Decorative laminates.
Sales Mgr.—R. W. Jorgensen
V. Pres. & Director of Plastic Sales—R. W. Jorgensen
Pur. Agt.—B. L. Allen

●**U. S. Rubber Co. Royalite Plastic Products,** Chicago (*4*)
Personnel: see p. 1103

INDIANA

●**Amos Packaging,** Edinburg, Ind. (*4*)
Max. size laminated sheet: 48"
Specialize in: Polyethylene
Pres.—Dale Amos
Vice Pres.—J. C. Kazimier
Sales Mgr.—Hamilton Moran
Pur. Agt.—Walter Parmer

Crown Tool, Wabash
Specialize in: nylon coil forms
Pres.—James M. Hipsher
V. Pres., Treas. & Pur. Agt.—Leo R. Kastner

Niles Corp. South Bend. (*4*)
Pres. & Pur. Agt.—Loren Schafer
V. Pres.—M. A. Schafer
Sales Mgr.—L. Schafer

IOWA

Farley & Loetscher Mfg. Co., Plastics Div. Dubuque (*1, A, B*)
Max. size laminated sheet: 36" x 84"
Pres.—J. M. Burch, Jr.
V. Pres.—A. E. Loetscher
Pur. Agt.—L. S. Streinz

●Indicates Advertiser.

MARYLAND

Fawn Plastics Co. Inc. Baltimore (*4*)
Specialize in: laminating heavy acrylic sections optically clear.
Pres. & Pur. Agt.—Robert D. Brickett
V. Pres.—John Franzone
Sales Mgr.—William Reese

Malco Plastics, Inc. Baltimore (*4, A, B*)
Max. size laminated sheet: 21⅛ x 25¾
Pres.—Lee Lawrence
V. Pres., Sls. Mgr. & Pur. Agt.—Howard B. Verbit

MASSACHUSETTS

●**Bolta Products Division, The General Tire & Rubber Company,** Lawrence, (*1, 2, 4, A*)
Specialize in: lamination of thermoplastic and thermosetting plastics in both sheet and molded form.
Personnel: see p. 1079

Form-A-Lite, Inc. Northbridge (*1, 2, 4, A, B*)
Max. Size laminated sheet: 54 x 112
Specializing in: 1/16" high pressure decorative laminates 1/16" high pressure decorative laminates 1/16" high pressure decorative laminates with ¼" to 1" backing, a full range of electric laminates
Pres.—Alexander N. Bronsten
Sales Mgr.—Jay R. Schaeffer
Pur. Agt. and Plant Mgr.—Seymour A. Buchine

Laminated Sheet Products Corp., Norwood (*A*)
Max. size rolled tubing: 2" Dia.
Pres.—J. M. Tomb
V. Pres.—H. M. Tomb
Pur. Agt.—Julius Dolloff

Leathertone, Inc. Boston (*1, A, B*)
Max. size laminated sheet: 24 x 54" also continuous rolls
Specialize in: decorative laminates (flexible and rigid thermoplastics) for handbags-eye glasses-etc. industrial laminates for defense and research
Personnel: see p. 1106

North East Laminates, Inc. Methuen. (*4, A, B*)
Max. size laminated sheet: 49" x 144"
Specialize in: vinyl to metal, vinyl to hard board
Pres.—Joseph A. Leone, Jr.
Exec. V. Pres.—Robert S. Kesler
Sales Mgr.—Charles A. Wustlich
Pur. Agt.—Robert S. Kesler

● **Parkwood Laminates, Inc.** Wakefield (*1 A, B*)
Max. size laminated sheet: 36 x 120
Pres. & Sales Mgr.—Sherman R. Thayer
V. Pres.—Paul B. Leverette
Pur. Agt.—Vivian Aston

Pine-Wood Plastic Co. Inc. Cambridge (*1, B*)
Max. size laminated sheet: 48 x 96
Specialize in: decorative plastic on plywood resin bonded hot pressed panels, tops.
Pres. & Sales Mgr.—Harry L. Wood
Pur. Agt.—G. Howkins

Plastic Industrial Products, Inc. Somerville
Specialize in: vinyl and polyethylene shapes
Gen. Mgr.—John E. Beaumont
Pur. Agt.—I. M. Paridon

Reiss Associates, Inc. Lowell (*1, B*)
Max. size laminated sheet: 48 x 120, 30 x 144
Pres.—Ernest Reiss
V. Pres.—Alfred M. Reiss
Sales Mgr.—Roger G. Landers
Pur. Agt.—Arthur C. Carnes

● **Sandman, Eli, Co.** Worcester
Specialize in: impregnating and coating on fiberglass cloth and also vinyl impregnated fiberglass screen.
Personnel: see p. 1106

Springfield Moulders, Inc. Monson
Specialize in: industrial molding and short-runs
Pres.—Victor E. Rosenlund
V. Pres.—Gilbert E. Stacy

Trimount Plastic Co. Inc. Arlington (*1, 4, A, B*)
Max. size laminated sheet: 54 x 112
Specialize in: epoxy, decorative rigid and flexible laminates; convertible rear window flexible AS-6
Pres.—Arthur S. Braverman
Treas.—Seymour A. Buchine
Sales Mgr.—Edward Thorp
Pur. Agt.—Arthur S. Braverman and Edward Thorp

MICHIGAN

Acme Laminating & Plastics Co. Detroit (*4, A, B*)
Max. size laminated sheet 24" x 24"
Personnel: see p. 1103

Bangor Plastics, Inc. Bangor, (*2*) (*A*)
Specialize in: industrial casters and timing gears. High impact material
Pres.—Victor Miller
V. Pres. & Treas.—E. O. Wokeck
Sales Mgr.—E. O. Wokeck
Pur. Agt. & Secy.—G. F. Wokeck

●**Cadillac Plastic & Chemical Co.** Detroit (*1, 4, A*)
Max. size laminated sheet: 54" x 80"
Specialize in: laminating flexible vinyl sheeting
Pres.—Robert B. Jacob
V. Pres.—Richard J. Jacob
Sales Mgr.—Lloyd R. Marentette
Pur. Agt.—Frank Barnard

● **Detroit Macoid Corp.** Detroit (*2, 3*)
Max. size laminated sheet: 48" x 96"
Pres.—G. S. Hendrie, Sr.
V. Pres. & Treas.—J. E. Gould
Sales Mgr.—J. E. Gould
Pur. Agt. & Secy.—S. D. Bradley

Duralastic Products Co. Detroit (*A, B*)
Max. size laminated sheet 3 x 6
Personnel: see p. 1080

● **Fabricon Products—Div. Eagle Picher,** River-Rouge (*1, B*)
Max. size laminated sheet: 4' x 10'
Pres.—L. A. Fisher
Ass't. to the Pres.—C. L. Keller
Sales Managers—J. T. Galvin, Molded Div., R. C. Fontham, Plastics Impregnating Div., C. E. Feltner, Palinated Plastics
Pur. Agt.—J. E. Steiner

Horstil Industries Company, St. Clair Shore (*2, A*)
Max. size rolled tubing: 12"
Standard length tubing: 44" to 96"
Specialize in: rolled round & square tubing for tooling, coil forms and ducting.
Pres. & Pur. Agt.—H. H. Stilson, Jr.
V. Pres. & Sls. Mgr.—A. A. Stilson

Haskelite Mfg. Corp. Grand Rapids (*3, A*)
Max. size laminated sheet: 48 x 144
Pres.—A. N. Williams
V. Pres. in charge of sales—E. W. Stoner
Sls. Mgr.—B. J. Werk
Pur. Agt.—F. W. Mitchell

Reynolds Plastics, Inc. Walled Lake
Specialize in: experimental & model work
Pres.—George Kovacs
V. Pres.—H. B. Ben, J. A. Soltis
Sales Mgr.—H. B. Ben
Pur. Agt.—R. Wallet

Zenith Plastics Co. Ypsilanti
Specialize in: vacuum forming
Personnel: see p. 1104

MINNESOTA

Mayon Plastics, Hopkins
Specialize in: vinyl food & industrial hose from .25" to 2½" I. D. flexible clear and colored.
Partners—C. B. Thomes, R. D. Johnson, M. C. Nelson, M. Standish.
Gen. Mgr., Sls. Mgr. & Pur. Agt.—R. D. Johnson

Perma Seal Plastic Products Co. St. Paul (*4*)
Max. size laminated sheet: 12" x 18"
Pres.—Ralph H. Oby

MISSOURI

Hanley Plastics Company, St. Louis (*4, B*)
Max. size laminated sheet: laboratory 10" x 8"
Specialize in: hand layups, models, plastic moulds, jigs, and fixtures, and in new product development in these thermosetting materials. Consulting and research

George A. Kelley, Fredericktown
Max. size rolled tubing: extruded tube 1/16"-8" dia.
Max. size molded tubing: shapes to 4" width rods from 1/16"-up
Standard length tubing: to customer specification
Specialize in: close tolerance tubular & shape parts—small experimental runs —production runs
Owner—George A. Kelley

● **National Plastic Product Co.,** Odenton (*1, B*)
Max. size laminated sheet: 4' x 10'
Pres.—E. Winer
V. Pres.—A. Winer
Sales Mgr.—J. R. Brown
Pur. Agt.—D. J. Anderson

NEBRASKA

Kerr, R. W. Plastic Co. Hastings (*1, 2, 4, A, B*)
Pres.—R. W. Kerr
V. Pres.—Charlotte Kerr

Kerrco Products, Lincoln (*1, 2, 4, A, B*)
Max. size laminated sheet: 32" x 44"
Pres.—R. W. Kerr
Sls. Mgr.—D. W. Kemphill

NEW HAMPSHIRE

Keller Products, Inc. Manchester (*2, 3, 4, A, B*)
Pres.—Robert R. Keller
V. Pres.—John C. Stanhope
Sales Mgr.—James Ellet

NEW JERSEY

Carpenter, L. E. & Co. Wharton (*4, B*)
Personnel: see p. 1098

● **Davis, Joseph Plastics Co.** Arlington, (*1, 4, A, B*)
Max. size laminated sheet: 22" x 52"
Personnel: see p. 1082

● **Emeloid Co. Inc.** Hillside (*4, A, B*)
Max. size laminated sheet: 21 x 25
Pres.—M. P. Leeds
V. Pres.—J. S. Freundlich
Sales Mgr.—G. W. Emerson
Pur. Agt.—Mrs. Florence Headley

Glassoloid Corp. of America, Clifton (*4*)
Max. size laminated sheet: 24" x 52, 30 x 40"
Specialize in: flat bed laminators-decorative coating, vacuum forming
Pres.—Walter A. Roembke
V. Pres.—W. A. Frazier
Sls. Mgr.—Jim Campbell, Jr.
Pur. Agt.—R. S. Thurston

Gomar Mfg. Co. Inc. Linden (*4, A, B*)
Max. size laminated sheet 54"

Hydrawlik, Roselle
Max. size molded tubing: 2" diameter
Specialize in: (A) tubing, (B) sealed end container tubes
Pres.—George A. Brown, Sr.
V. Pres.—Robert C. Brown
Sls. Mgr.—George A. Brown
Pur. Agt.—M. M. Johnson

Plastex Process Co. Maywood (*4, A*)
Specialize in: laminating nylon film to webs of material up to 4" width.

Plastic Laminating Corp. Vaux Hall, (*4, A, B*)
Max. size laminated sheet: 38 x 48, 24 x 54
Specialize in: thermoplastic laminations, planishing, plastic materials for laminating-placo laminating presses.
Pres. & Sales Mgr.—Joseph Di Bella
V. Pres.—Vincent T. Cooney
Pur. Agt.—Terry Kane

● **Polyplastex United, Inc.** Union (*1, 4, A, B*)
Max. size laminated sheet: 48" x 96"
Personnel: see p. 1106

Ridge Printing Co. Inc. Ridgefield (*4*)
Specialize in: lamination of vinyl to vinyl, paper cotton & flannel, knitback matl., non-woven fab. and mylar
Pres. & Pur. Agt.—George M. Cohan

Rondale Company, Inc. Roselle (*4, A, B*)
Max. size rolled tubing: 56" width
Specialize in: continuous laminating 24" to 56" wide—6 gauge to 60 gauge thickness cloth, paper flexible vinyl film and vinyl sheeting, flexible embossed vinyls, expanded plastics.
Pres.—J. Rubin
V. Pres.—A. Eddy
Sales Mgr. & Pur. Agt.—S. Rubin

Spiral Glas Pipe Co. New Brunswick
Max. size tubing: 5" Have machine capacity for 6" but no tools
Standard length tubing: 20'
Specialize in: high pressure chemical resistant piping.
Pres.—Carl de Ganahl
Sls. Mgr.—C. Brice de Ganahl
Pur. Agt.—Amy Mackenzie

NEW YORK

Anorgana G. M. G. H., New York
Max. size rolled tubing: 500 mm dia.
Specialize in: unplasticized P. V. C. film, sheet tubing

Armen, Inc., Long Island City, (*2, 4*)
Max. size laminated sheet: 38½" x 54"
Specialize in: fluorocarbons
Pres.—Armen Garabedian
V. Pres.—Edward F. Wiseman
Pur. Agt.—Roland Perry

● **Busada Mfg. Corp.,** Maspeth,
Max. size molding tubing: 9" O. D.
Standard length tubing: 6 ft. & 20 ft.
Specialize in: transparent butyrate tubing & pipe
Pres. & Sales Mgr.—John K. Busada
V. Pres.—V. A. Busada

Du Verre, Inc., Buffalo (*2*)
Max. size molded tubing: 84" x 1, D.
Standard length tubing: 6'-0"
Specialize in: duct systems, hoods, stacks, fans, tanks, other special shapes
Pres.—J. R. Kelly
Sales Mgr.—T. F. Killeen
Pur. Agt.—Henry Hasbrouck

Glasply Corp., Mount Vernon (*2*)
Max. size rolled tubing: (Low Pressure) 48" Dia.
Standard length tubing: 20 ft. Max.
Pres., V. Pres., Sls. Mgr. & Pur. Agt.—Frank A. Lambert

Glass Laboratories, Inc., Brooklyn (*B*)
Specialize in: decorative trim
Pres.—Abraham Shanok
V. Pres. & Sls. Mgr.—Jesse P. Shanok
Pur. Agt.—Victor Shanok

● **Hopp Plastics,** New York (*1, 4*)
Max. size laminated sheet: 23 x 36
Pres.—Hermann Hopp
V. Pres.—Philip Hopp
Sales Mgr. & Pur. Agt.—George Hopp

Ideal Gold Stamping Co., New York (*B*)

Identification Service Corp., New York (*1*)
Max. size laminated sheet: 20" x 50"
Pres. & Pur. Agt.—H. G. Schonzeit
V. Pres. & Sls. Mgr.—J. H. Schonzeit

● Indicates Advertiser.

Lewis, J. P. Co., Beaver Falls (*1, A*)
Max. size laminated sheet: 40" x 60"
Specialize in: low cost electrical grade laminates
Pres.—James P. Lewis
V. Pres.—E. S. Nuspliger
Gen. Mgr.—J. C. Parsell
Pur. Agt.—F. C. Pressaw

Marbak, Inc., Brooklyn (*4, A*)
Personnel: see p. 1106

Murray Plastics Company, Poughkeepsie (*A*)
Max. size rolled tubing: 6" I. D.
Max. size molded tubing: 7/8" O. D.
Standard length tubing: 40"; 46"; 60"
Pres.—A. Murray

Pathway Plastic Corp., Mt. Vernon (*1, 4, A, B*)
Max. size laminated sheet: 16" x 20"
Specialize in: laminating acrylics
Pres., Sales Mgr. and Pur. Agt.—Martin Fox
V. Pres.— Ludwig Geist

Plastic Center, Rochester (*1, 4*)
Max. size laminated sheet: 12 x 12
Specialize in: laminated photos, cards display pcs. & documents
Pres. & Sales Mgr.—G. Dudly Ward
V. Pres. & Pur. Agt.—John W. Proctor

Printloid Plastics, Inc., New York (*1, 4, A*)
Max. size laminated sheet: 20 x 24
Pres.—G. Martin
V. Pres.—M. Martin
Sales Mgr.—J. M. Wodiska
Pur. Agt.—Miss A. Minner

●**Rubber Corp. of America,** Hicksville (*4, A, B*)
Max. size laminated sheet: 24" x 52"
Personnel: see p. 1106

Rudd Plastic Fabrics Corp., Brooklyn (*4, A, B*)
Max. size laminated sheet: 54" x 24"
Personnel: see p. 1106

Shoe Form Co., Inc. Auburn (*1*)
Max. size laminated sheet: 20" x 50"
Pres.—Frank P. DeWitt
Sales Mgr.—Gordon N. Tutton
Pur. Agt.—David E. Gregory

Sommers Plastic Products Co., New York (*B*)
Max. size laminated sheet: 25 x 54
Specialize in: decorative laminations
Personnel: see p. 1106

Spaulding Fibre Company, Inc., Tonawanda (*1, A*)
Max. size laminated sheet: 41" x 49"
Max. size rolled tubing: 6"
Standard length tubing 37"
Specialize in: vulcanized fibre, industrial laminates.
Pres.—C. C. Steck
V. Pres.—E. C. Knobloch
Pur. Agt.—A. P. Hardleben

Superior Laminating Co., New York (*4*)
Max. size laminated sheet: 5" x 8"
Specialize in: laminating medals, coins, insignia, etc.
Owner, Sales Mgr., & Pur. Agt.—Edward Rosner

Virginia Plak Co., New York (*4*)
Max. size laminated sheet: 35" x 38"
Specialize in: vinyls
Pres.—Edward A. Rosenberg
Sales Mgr.—Sydney N. Weis

OHIO

●**American Agile Corporation,** Maple Heights, (*1, 4*)
Specialize in: Custom Fabrications Extrusion, molding
Personnel: see p. 1085

Barron, J. E. Plastics, Inc., Cincinnati (*4, A, B*)
Max. Size Lam. Sheet 20 x 24.
Max. Size molded tubing: 18"
Standard length tubing 48" to 53" long on cast material 72" on extruded
Specialize in: custom work and stock materials.
Personnel: see p. 1085

Conneaut Rubber & Plastics Co., Conneaut
Specialize in: custom compounding and extrusions
Pres.—J. M. W. Chamberlain
V. Pres.—R. C. Hunter
Sales Mgr.—J. H. Davison
Pur. Agt.—J. B. Phipps

Francis Industries, Pataskala (*2, A*)
Max. size molded tubing: 8 Ft. diameter 10 Ft. long
Specialize in: high strength, electrical and chemical tubing also tubular glass arrows
Pres. & Sls. Mgr.—R. J. Francis
V. Pres. & Pur. Agt.—C. A. Francis

●**General Tire and Rubber Co.,** Akron (*2, A*)
Personnel: see p. 1085

Glastic Corp. Cleveland (*2*)
Max. size laminated sheet: 36 x 72"
Specialize in: flat sheet laminates

Greene, Ray & Company, Toledo (*2*)
Pres.—Ray Greene
V. Pres.—Jan Greene
Sls. Mgr.—Robert Crist
Pur. Agt.—Ken Greene

●**Seiberling Rubber Co. Plastics Div.,** Newcomerstown (*1, 4, A*)
Max. size laminated sheet: 48" x 96"
Personnel: see p. 1086

PENNSYLVANIA

Allegheny Plastics, Inc., Coraopolis (*4*)
Max. size laminated sheet 30" x 30"
Max. size molded tubing
Standard length tubing: various

Calcon Mfg. Co., Inc., Washington
Specialize in: plastic extrusions, vinyl and poly vinyl chloride tubing 10" dia.
Pres. Joseph A. Morosco
Sls. Mgr.—James C. Morosco
Pur. Agt.—A. W. Moore, Jr.

Commonwealth Pipe & Tubing Inc., Philadelphia
Specialize in: extruded coating over solid or hollow cores.
Pres., Sls. Mgr. & Pur. Agt.—Harold B. Heft

Curry Arts Molding & Laminating Co., Scranton (*1, 2, A, B*)
Max size laminated sheet: 36" x 38"
Specialize in: acrylic decorative sheets (18" x 24")
Pres. & Partner, & Sls. Mgr.—Harry H. Rosenthal
V. Pres.—Kurt Adler
Partner and Pur. Agent-Kurt Adler

●**Laminations, Inc.,** Scranton (*4, A, B*)
Max. size laminated sheet: 54" x 144"
Pres.—John Mulpowney
Vice Pres.—M. J. Lynch

Plastic Laminating Co., Swarthmore (*1, 4, A*)
Max. size laminated sheet: 23¼ x 31"
Owner, Sales Mgr. & Pur. Agt.—Samuel M. Dodd, Jr.

●**Scranton Plastic Laminating Corp.,** Scranton (*2, 4, A, B*)
Max. Size laminated sheet: 50" x 108"
Personnel: see p. 1107

Strick Plastics, Perkasie (*2, 3, A*)
Max. size laminated sheet: 50" x 100"
Pres.—C. Bradford Sheppard
V. Pres.—Solomon Katz
Sales Mgr.—R. W. Jakubek

Synthane Corp., Oaks (*1, 2, A*)
Max. size laminated sheet: 36" x 36"; 72" x 36" 96" x 24"
Max. size rolled tubing: 26" OD
Max. size molded tubing 4" OD
Standard length tubing: 18"-36"-48"-96"
Specialize in: sheets, rods, tubes, molded macerated, molded laminated fabricated parts
Pres.—R. R. Titus
Sales Mgr.—E. E. Smith

●**United Laminators, Inc.,** Mayfield (*A, B*)
Max. size laminated sheet: 50" x 72"
Pres.—M. Bros
Vice Pres.—Herbert Perry

Washington Plastics Co., Sharon (*2, A, B*)
Pres.—Harry Northover.
V. Pres.—Paul Richley, Sr.
Sales Mgr.—Harry Northover

Westlake Plastics Co., Lenni Mills (*4, A*)
Max. Size Lam. Sheet: 20" x 40"
Personnel: see p. 1088

Willson Camera Co. Inc., Havertown (*1, A, B*)
Max. Size Lam. Sheet: 22" x 50"
Pres.—Thomas C. Willson, Jr.
V. Pres.—Nathan S. Weintraub
Sales Mgr.—Nathan S. Weintraub

RHODE ISLAND

Anchorage Plastics, Inc., Warren
Max. size rolled tubing: ½" to 30" Dia. x 10 ft. long
Standard length tubing: 10 ft.
Specialize in: Fibrous glass cloth polyester
Personnel: see p. 1088

SOUTH CAROLINA

Westinghouse Electric Corp., Micarta Division, Hampton (*1, 2, A, B*)
Max. size lam. sheet: 4' x 8'
Max. size rolled tub.: 96" length, 48" I. D.

● Indicates Advertiser.

Stand. length tub.: 48"
Gen. Mgr.—G. H. McBride
Sales Mgr.—S. F. Davies
Pur. Agt.—C. R. Keller

VIRGINIA

O'Sullivan Rubber Corp., Winchester (*4*)
Personnel: see p. 1107

Universal Moulded Products Corp., Bristol (*1, 2*)
Max. size rolled tubing: 32" Diameter
Standard length tubing 10 ft. and 20 ft.
Pres.—T. H. McKoy, Jr.
V. Pres.—Dr. Robert J. Nebesar
Pur. Agt.—J. G. Barnes

WASHINGTON

Pacific Plastics Co., Inc., Seattle (*1, 2, 4,*)
Pres. & Sales Mgr.—Ben Rosen
V. Pres.—Allen Rosen
Pur. Agr.—Bertha Seder

Western Plastic Inc., Spokane (*1*)
Max. Size: 6" x 6" (lam. sheet).
Pres. & Pur. Agt.—Gabe E. de Roetth
V. Pres.—Paul Houston
Sales Mgr.—Robert D. McGoldrick

WISCONSIN

● **Decar Plastic Corp.,** Middleton (*1, B*)
Max. size laminated sheet: 48" x 72" x 36" x 96"
Pres. & Sls. Mgr.—Ralph L. Fossier, Sr.
V. Pres. & Tech. Director:—T. Walter Noble
V. Pres. & Gen. Mgr.—George W. Johnson

Fiberesin Plastics Co., Oconomowoc (*1, B*)
Max. size laminated sheet 48" x 96"
Specialize in: school & office desk tops and furniture panels
Pres.—W. W. Turner
V. Pres.—David McCalla
Sales Mgr.—Robert W. Healy
Pur. Agt.—R. J. Lyman

Presco Plastics, Milwaukee (*1, 4*)
Max. size laminated sheet: Various size presses
Pres. & Pur. Agt. E. K. Schroeter
Manager—H. Schauf

Northern Plastics Corp., La Crosse (*1*)
Max. size lam. sheet: 39" x 47"
Personnel: see p. 1102

ENGLAND

BX Plastics Ltd., London (*4, A*)

● **Microcell, Ltd.,** London (*1, 2, 3*)
Max. size laminated sheet: 8' x 4'
Max. size rolled tubing: 8' long, x 12" dia.
Max. size molded tubing (Standard)
8' long x 2'6'
Standard length tubing: 8'
Pres.—Henry Kremer
V. Pres.—D. J. Hodgson & L. R. Rutherford
Sales Mgr.—E. Cook
Pur. Agt.—E. Hesk

REINFORCED PLASTICS PROCESSORS

CALIFORNIA

Airconductors, Compton
Types of molding done: low pressure plaster, plaster & metal molds. Tension wrap & vacuum bag molding
Type of resins and reinforcements used: thermal & thermal setting resins pre-impregnated in any cloth phenolics-epoxies—silicones—extreme Hi-temp resins for jet & missle use. Non-metallic sheeting, flexible & rigid. Custom molding military & aircraft. Also sewn products.
Pres.—Fred E. Sindars
V. Pres.—D. C. Cairns
Sales Mgr.—F. Sindars
Pur. Agt.—H. Sindars

Automatic Plastic Molding Co., Berkeley
Presses: 4–12 x 12 platen 24" daylight; 2–16" x 18" platen 28" daylight; 2–28" x 32" platen 32" daylight; 1–14" x 14" platen 26" daylight; compression with matched steel molds 9 fiberglass presses.
Type of resins and reinforcements used: polyester resin
Number preformers: 2–28" 2 Preform ovens.
Pres.—Forrest Engelhart
V. Pres. & Sales Mgr.—A. J. Carlson
Pur. Agt.—Forrest Barnes

Chemold Company, Santa Monica
Types of molding: Hydraulic press molding on matched metal dies.
Presses: 4–75 ton 3' x 5', 48" daylight; 2–150 ton, 4' x 8', 72" daylight; 1–750 ton, 92" x 130", 40" daylight.
Size of flat laminate sheet: 4' x 12' maximum
Type of resins and reinforcements used: polyesters, epoxies, phenlies, glass mat, glass cloth, chopped roving.
Number and sizes of preformers: 1–48" with ancillary over equipment.
Type of fabrication: any custom molding of contoured parts; flat and ribbed building panels and laminated plywood foam, and honey comb up to 4' x 12'
Pres.—K. D. Smith
V. Pres.—L. R. Dailey
Sales Mgr.—E. Eberli
Pur. Agt.—Peter Hunt

Chemtron Fiber Glass Co., El Monte
Types of molding done: contact, vacuum, press, cold molding; steel aluminum—wood, reinforced plastics, plaster.
Presses: 1–24" x 24" x 30"; 1–60" x 120" x 36"; 1–48" x 48" x 72"; 1–30" x 60" x 60"; 1–30" x 54" x 48"
Size of flat laminate sheet made: 60" x 120"
Type of resins and reinforcements used: Epoxy-polyester, phenolic, glass cloth, mat-roving, Sisal Jute, etc.
Type of fabrication: vacuum, molded, hand lay up, matched die cold forming.
Personnel: see p. 1074

Copolymer Corp., Los Angeles
Types of molding done: compression steel aluminum.
Presses: 9 presses 60" x 120" x 250 ton
Type of resins and reinforcements used: polyester, epoxy-phenolic, fibrous-glass
Number and sizes of preformers: One 45" Preform
Type of fabrication: assembling
Pres.—John. H Wyckoff

Crest Molded Products, Inc., Arcadia
Number and sizes of preformers: One–2½" single-stroke.
Pres.—Charles Martins
V. Pres.—Stephen Civerolo
Sales Mgr. & Pur. Agt.—K. R. Mergen

Eldon Mfg. Co., Los Angeles
Types of molding done: match metal, bag molding, contact lay up.
Type of resins and reinforcements used: phenolic, epoxy, polyester, silicone
Number of sizes of preformers: Number: 1
Type of fabrication: high pressure, high temperature ducts, honey comb structure, dry ply and wet lay-up.
Pres.—Robert Silverstein
V. Pres.—Walter Burroughs
Sales Mgr.—Darrel Francy, Gen. Mgr.
Pur. Agt.—Louis Berkowitz

Filon Plastics Corp., El Segundo
Type of molding done: fibrous-glass and nylon reinforced polyester, resin building panel under the trade name Filon These panels are produced on a patented, continuous electronically controlled process.
Size of flat laminate sheet: Widths of 24", 30", 36" and 48", standard lengths of 8', 10', and 12' available also in roll lengths. Maximum width 48" and standard thicknesses 1/32", 3/64", 1/16" and 3/32"
Type of resins and reinforcements used: light stabilized polyester resin and silane finished glass fibers.
Pres.—D. S. Perry
V. Pres.—Manufacturing: G. R. Huisman
Sales Mgr.—Alex Zakarian
Pur. Agt.—Frederick A. Nichols

● Indicates Advertiser.

General Fiber, Inc., Div. of General Plastics Corp., Los Angeles
Types of molding done: fibrous glass and polyester resin; premix. Matched hardened steel dies.
Presses: 4–16 x 18 DL 27, 2–18 x 28 DL 28, 1–32 x 40 DL 32, 1–24 x 30 DL 18, 1–48 x 48 DL 54, 1–30 x 40 DL 48
Type of resins and reinforcements used: polyester, fibrous glass, sisal, and inert fillers.
Personnel: see p. 1108

Gill, M. C., Corp., El Monte
Types of molding done: flat sheet, formed parts.
Presses: 1–72" x 168", 48" daylight; 1–20" x 38", 24" daylight.
Size of flat laminate sheet: Max. 72" x 168", Std. 48" x 144"
Type of resins and reinforcements used: polyester, epoxy, phenolic, silicone, all low pressure—fillers, glass, cotton, paper & jute
Pres. & Sls. Mgr.—M. C. Gill
V. Pres. & Pur. Agt.—E. W. Gill

Lynch Asbestos Co., Los Angeles
Continuous laminating: glass, 42" wide
Type of resins and reinforcements used: polyester-glass
Pres.—R. O. Lynch
V. Pres.—J. C. Hunter
Pur. Agt.—C. Gruen

Marplex Co., El Segundo
Types of molding done: matched metal molds
Presses: 9 presses: 24" x 24" platens to 30" x 40" platens daylight 3' to 5'
Size of flat laminate sheet: 2' x 3'
Type of resins and reinforcements used: polyester resins, fibrous glass reinforcement
Number and sizes of preformers: 3, to 30" dia.
Type of fabrication: specializing in lamp shades & misc. lighting parts, giftware, misc. custom molding.
Pres. & Gen. Mgr.—E. Marx
Pur. Agt. & Factory Mgr.—H. Mayer

Mica Corporation, Culver City
Types of molding done: printed circuit, epoxy glass cloth, copperclad & unclad laminate.
Presses: 1 press, 8 platens, 4" daylight
Size of flat laminate sheet: 18" x 36"
Type of resins and reinforcements used: epoxy glass cloth.
Personnel: see p. 1090

Olympic Plastics Co., Inc., Los Angeles
Types of molding done: matched metal molding.
Presses: 11, 36 tons, 150 tons platens to 4' x 5', daylight to 7'.
Number and sizes of preformers: 1–36".
Pres.—David Rome
V. Pres.—David C. Siteman
Chief Engr.—Willard Lundberg
Pur. Agt., Secy.-Treas.—Harry Scott

Omohundro, Paul, Company, Paramount
Types of molding done: membrane molding, press molding
Presses: 1–0–96" daylight; 87" x 48" platen, 1–0–84" daylight; 51" x 36" platen.

Type of resins and reinforcements used: polyester, epoxy, phenolic, silicone with fibrous glass.
Type of fabrication: military specification parts for aircraft, missiles & electronics.
Pres.—Paul Omohundro
V. Pres.—James R. Johnson
Pur. Agt.—G. Sigurdson

Parker Manufacturing Co., San Diego
Types of molding done: low pressure flat & corrugated sheet.
Size of flat laminate sheet: flat 42" x 144", maximum corrug. 40" x continuous
Continuous laminating: widths: 26", 27½", 34" & 40"
Thickness: .050 (1¼ oz.), .060 (2 oz.), .090 (3 oz.), glass
Type of resins and reinforcements used: unsaturated polyester, reinforcement, fibrous glass
Type of fabrication: translucent reinforced fiberglass building sheets, corrugated & flat, & butler corrugation.
Personnel: see p. 1090

Plastic Age Sales, Inc., San Fernando
Types of molding done: all types metal molds, reinforced molds, mat molds, fabric layup, gunk molding.
Presses: see compression presses.
Size of flat laminate sheet: 48" x 120".
Type of resins and reinforcements used: glass, nylon, orlon, mineral, asbestos, polyester, alkyd, silicone, D. A. P., phenolics
Number and sizes of preformers: 1–custom-size unlimited.
Personnel: see p. 1090

Polyply Company, San Diego
Size of flat laminate sheet: 48" x 96"
Type of resins and reinforcements used: polyester.
Pres.—George A. Baker

Reflin Co., San Diego
Types of molding done: centrifugally molded fibrous glass reinforced plastic pipe
Type of resins and reinforcements used; polyester, fibrous glass, mat and cloth
Pres. & Sales Mgr.—Louis L. Potomac
Pur. Agt.—L. P. Kehres

Reinforced Plastic Tubing Co., Gardena
Types of molding done: laminating fiber glass tubing
Proprietor—Bernard Robinson

Reinhold Engineering & Plastics Co., Norwalk
Types of molding done: laminating, vacuum type molds and matched metal, high pressure-steel mated tooling; glass filament winding-mandrels.
Presses: high pressure reinforced glass moldings use standard compression presses listed under custom molders.
Size of flat laminate sheet: glass laminated sheet, phenolic resin to 4 ft. square.
Continuous laminating: glass tubing 3 to 3½" ft. widths, various thicknesses
Type of resins and reinforcements used: glass cloth, epoxy resins, phenolic resins and polyester resins.
Type of fabrication: aircraft component assemblies and rocket and missile details; filament winding of rocket motor tubes
Personnel: see p. 1090

Rippolite Plastic Products, Inc., Burbank
Size of flat laminate sheet: 40" x 8' x 10".
Type of resins and reinforcements used: polyester resins and fibrous glass reinforcements.
Personnel: see p. 1090

● **Swedlow Plastics Co.,** Los Angeles
Presses: 11 presses; max. area 5' x 10'; max. daylight 80".
Size of flat laminate sheet: max. 5' x 10'.
Continuous laminating: .005 to .100–36" to 60" width.
Type of resins and reinforcements used: fibrous glass, nylons, cotton, paper polyester, acrylics, nylon.
Number and sizes of preformers: 1–48"
Personnel: see p. 1090

Thompson, H. I., Fiber Glass Co., Los Angeles
Types of molding done: aircraft reinforced glass plastic, matched metal & vacuum-bagged molds.
Presses: (2) 3' x 4' x 9' daylight; (2) 3' x 3' x 2' daylight; (2) 2' x 2' x 6' daylight; (1) 2' x 2' x 18" daylight; (1) 1' x 1' x 2' daylight.
Size of flat laminate sheet: 3' x 4' maximum.
Type of resins and reinforcements used: polyesters, epoxies, phenolics, and silicones, on glass and asbestos.
Number and sizes of preformers: One (1) 3' x 3'.
Type of fabrication: aircraft radomes, preform, and compression molding.
Pres.—Harry I. Thompson
V. Pres., Executive—William C. Winterhalter
Sales Mgr.—William E. Benke
Pur. Agt.—Edward C. Titus

Wal-Mar Plastics, Inc., Torrance
Types of molding done: cast form blocks, laminated hydro-press dies, drop hammer dies, holding fixtures, matched laminated dies, plastic patterns.
Type of resins and reinforcements used: epoxy, polyester, glass cloth and mat.
Type of fabrication: dies, holding fixtures, patterns and master patterns.
Pres.—Wallace J. De George
V. Pres.—Mark L. De George
Sales Mgr.—Ritson A. Ballinger
Pur. Agt.—John W. Burgess

Wizard Boats, Inc., Costa Mesa
Types of molding and molds used: contract and vacuum laminating, low pressure, male or female-oven curing.
Resin and reinforcements used: polyester resin, glass cloth, woven roving, glass mat for reinforcement.
Fabrication: boats, swimming pools, astrodomes, bathtubs, boxes.
Pres.—Harold Hauflaire.
V. Pres.—C. D. Horne, C. B. Melone
Sales Mgr.—C. D. Horne
Pur. Agt.—R. A. Hawley

COLORADO

Plasticrafts, Inc., Denver
Types of molding done: matched metal molds
Presses: 4 Presses
Type of resins and reinforcements used: polyester, glass cloth and mat, epoxy
Pres.—T. H. Cooper
V. Pres. & Sales Mgr.—B. B. Butcher
Pur. Agt.—T. H. Cooper

CONNECTICUT

Bridgeport Moulded Products, Inc., Fairfield
Number and size of pref.: 5, misc.
Personnel: see p. 1106

● Indicates Advertiser.

Plastic Film Corp., Plainfield
Continuous Laminating: 60" width range on paper, glass and cloth
Type of resins and reinforcements used: vinyl & polyethylene
Personnel: see p. 1076

●**Waterbury Companies, Inc.,** Waterbury
Types of molding and molds used: taw pressure
Presses, platen area and daylight space: 1-113 Ton, 1-27 ton, 1-semi auto., 3 Stu Preform
Personnel: see P. 1075

DELAWARE

●**Continental-Diamond Fibre Corp.,** Newark
Types of Molding: phenolic and polyester
Size of flat laminate sheet made: 38" x 72" polyester laminate
Type of resins and reinforcements used: paper, cotton fabrics for phenolics glass mat for polyesters.
Type of fabrication: drilling, sawing, turning
Personnel: see p. 1076

Haveg Industries, Inc., Wilmington
Types of molding done: 6
Presses: 6 up to 5' x 7'
Type of resins and reinforcements used: all types & thermoplastics, and thermosetting polymers.
Number and sizes of preformers: 2

●**National Vulcanized Fibre Co.,** Wilmington
Types of molding done: low pressure laminated sheet using matched metal molds
Presses: 1-36 x 96, 5" daylight; 1-36 x 46, 3¼" daylight; 1-36 x 42, 1¾" dayligh
Type of resins and reinforcements used: polyester resin with glass mat and roving
Number and sizes of preformers: 1" to 40' dia.
Type of fabrication: complete fabrication service
Personnel: see p. 1076

FLORIDA

Glascraft Co., Jacksonville
Types of molding done: Fibrous glass boats, tanks, custom-molding, metal, plastic molds
Type of resins and reinforcements used: all types of glass polyester-epoxy
Owner—Milton Dobrin

Lami-Plast Products Co., Tampa
Types of molding done: custom, acid tanks, ducts, & hoods boats steel, plastic and wood molds.
Type of resins and reinforcements used: polyester epoxy
Type of fabrication: custom molding
Pres., Sls. Mgr. & Pur. Agt.—Bernard N. Rothenberg
V. Pres.—Mary P. Rothenberg

Southern Plastic Products Co., Riviera Beach
Types of molding done: hand lay-up
Type of resins and reinforcements used: epoxy, polyester & fibrous glass
Type of fabrication: tooling and tool jigs
Pres. & Sales Mgr.—Tom Nuttall, Jr.
V. Pres. & Secy.—Veronica A. Nuttall

ILLINOIS

Bacon & Weber, Chicago
Type of fabrication: fibrous-glass, reinforced-castings in epoxy's or phenolics.

●**Brunswick-Balke-Collender Co.,** Chicago
Types of molding done: vacuum-bag molding, press molding, contact plaster, epoxy, metal spray, alum, steel.
Number of presses: 6 presses, platens; 4' 3" x 2' 2" to 6' x 8', daylight; opening up to 12'.
Type of resins and reinforcements used: polyester, phenolic, epoxy, fibrousglass cloth, mat.
Fabrications: radomes, honeycomb, for, sanwich, solid laminate.

Chicago Price Tag Mfg. Co., Chicago
Size of flat laminate sheet: 18" x 18"
Type of fabrication: (plastic-rigid & flexible sheet) embossing and die cutting.

●**Commercial Plastics Co.,** Chicago
Types of molding done: houseware item and custom molding for automatic & refrigeration mfg.
Pres.—Anton Scharl
Vice Pres.—Raymond Akter
Sls. Mgr.—E. W. Heeter

Crane Packing Co., Morton Grove
Types of molding: compression.
Type of resins and reinforcements used: teflon reinforced with glass fiber, carbon, graphite, copper, bronze, talc, calcium, fluoridex of other organic materials.
Pres.—Karl V. Rohlen
V. Pres.—Carl E. Schmitz
Sls. Mgr.—Vance E. Vorhees
Pur. Agt.—V. Grogleth

●**General American Transportation Corp., Plastics Div.,** Chicago
Types of molding done: matched metal molding.
Presses: 9 presses from 100 ton to 1000 ton.
Type of resins and reinforcements used: various types of resins with all types of fiber reinforcements.
Number and sizes of preformers: 5 Preform machines.
Pres.—William J. Stebler
V. Pres.—Frank E. Selz
Gen. Mgr.—Harry M. Jenkins
Pur. Agt.—Robert B. Silverman (Plastic Division)
Supervisor of Sales—James Nash
Director of Research & Development—Carl F. Massopust

●**Hawley Products,** St. Charles
Types of molding done: fiberous glass, pre form matched metal molds.
Number of presses: 1-60" x 84"-60" day; 1-30 x 40"-60" day; 3-30 x 40"-48 day.

Keystone Plastic Engineering Co., Chicago
Types of molding done: boats, polyestgr epoxy.
Type of resins and reinforcements used: polyester, epoxy, glass mat, glass cloth.
Type of fabrication: boats, misc.
Pres.—Fred M. Schukraft
Vice Pres.—Bernard Schukraft
Sales Mgr. & Pur. Agt.—Richard Schukraft

Multiplastics, Div. of Curd Enterprizes, Addison, Ill.
Types of molding done: vacuum, hand lay up & compression.
Size of flat laminate sheet: 4' x 10'.
Type of resins and reinforcements used: polyester, epoxy.
Personnel: see p. 1077

●**Molded Products, Division of Admiral Corp.,** West Chicago
Types of molding done: custom compression with matched metal molds; custom compression with epoxy plastic molds, hand lay up molding.
Type of resins and reinforcements used: all types of resins and glass sisal reinforcements.
Number and sizes of preformers: 2 with 36" turntables; 1 with 72" turntables; 1 with 48" turntables.
Personnel: see p. 1077

●**Plasticrafters, Inc.,** Chicago
Types of molding done: compression, steel molds.
Presses: 6 presses: 24" x 36" x 24" daylight.
Size of flat laminate sheet: 36 x 144.
Type of resins and reinforcements used: fibrous glass reinforced thermosetting resins.
Personnel: see p. 1077

●**Richardson Company,** Melrose Park
Type of fabrication: all types of machining.

Plano Molding Company, Plano
Number and sizes of preformers: 3-10 to 25 ton.
Pres.—James L. Henning
V. Pres. & Sales Mgr.—R. C. Yunger

United Die Models Inc., Chicago
Type of molding done and molds used: contact, vacuum bag, compression molding, plastic and wooden molds.
Resins and reinforcements: polyester and epoxy resin, glass cloth, mat and milled fiber.
Fabrication: duplication models, prototypes.
Pres.—Edwin R. Knize
V. Pres.—Elmer J. Knize
Sales Mgr. & Pur. Agt.—Alois R. Heinol

INDIANA

●**Amos Packaging,** Edinburg
Continuous Laminating: up to 48" width, up to .010" thick-paper, foils, films, extrusion coated and laminated with polyethylene
Pres.—Dale Amos
Vice Pres.—J. C. Kazimier
Sales Mgr.—Hamilton Moran
Pur. Agt.—Walter Parmer

●**General Tire & Rubber Co.,** Marion
Types of molding done: vacuum bag, contact, match, metal molding
Presses: 35 presses: platen areas ranging from 32" x 34" to 72" x 84", daylight to 96", tonnage 50 ton to 700 ton.
Size of flat laminate sheet: 4' x 01 sheet, thickness to ½".
Type of resins and reinforcements used: polyester epoxy, silicones, glass mat, roving, cloth, also sisal.
Number and sizes of preformers: 4 up to 48" dia.
Type of fabrication; mold, drill, sand.
Pres.—W. O'Neil
V. Pres.—H. M. Dodge
Sales Mgr.—Fred W. Dover

●**Polygon Plastic Company,** Walkerton
Type of resins and reinforcements used: polyester and epoxy; fibrous glass reinforcements.

●Indicates Advertiser.

Pres.—S. M. Shobert
V. Pres.—G. S. Parks
Sales Mgr.—E. R. Jaques

Plas-Steel Products, Inc., Walkerton
Types of molding done: extrusion of reinforced fiber glass rod stock.
Pres.—S. M. Shobert
V. Pres.—G. S. Parks
Sales Mgr.—E. M. Elliott

Pribble Plastics Products, Inc., New Haven
Types of molding done: hand lay-up, vacuum bag, matched metal.
Presses: 2-18 x 20, 28" Daylight, 2-13 x 18, 28" daylight; 1-30 x 36", 40" daylight.
Type of resins and reinforcements used: polyester, glass mat and cloth.
Pres., Sales Mgr. & Pur. Agt.—Wayne I. Pribble
V. Pres. & Plant Mgr.—John L. Haugarud

IOWA

Thombert, Inc., Newton
Type of fabrication: punching, sawing, drilling, turning, shearing.
Pres., Sales Mgr. & Pur. Agt.—Robert L. Smith
V. Pres.—Wilbur E. Edwards

KANSAS

Engineered Plastics, Inc., Baxter Springs.
Type of resins and reinforcements used: polyester, epoxy, epoxy-polyamid resins, glass fibres, dacron, etc.
Type of Fabrication: filament winding of spheroids, 6" min. through 59" dia.; reinforced tubes, 1½" I. D. thru 14" I. D. any wall x 20 ft. long, round or rectangular, straight or tapered.
Gen. Mgr.—W. Blake
V. Pres. & Prod. Engr.—C. K. Norris
Field Engr.—J. V. Smith
Sales Mgr.—R. J. Harris

Lamicell Engineering Co., Baxter Springs
Types of molding done: matched metal, bag, & hand lay-up.
Presses: 1-150 ton, 40" x 44" platen, 30" stroke, 60" daylight; 3-24" platen x 24" stroke, 35" daylight.
Type of resins and reinforcements used: polyester, epoxy, epoxy-polyamid.
Pres. & Gen. Mgr.—W. R. Blake
V. Pres. & Sales Mgr.—C. B. Nelson
Sales Mgr.—W. A. Barnett

Plastic Fabricating Co., Inc., Wichita
Types of molding done: low pressure laminating, glass-preform molding & premix from plastic, plaster and matched metal molds.
Presses: 36 x 48 platen, 48" daylight; 20 x 30 platen, 18" daylight; 40 x 50 platen, 60" daylight, 38 x 48 platen, 48" daylight, 30 x 30 platen, 36" daylight, (5 presses).
Type of resins and reinforcements used: resins: polyester, modified polyester, epoxy, phenolic: reinforcements, fiberglass, woven cloth, fibrous-glass mat, fibrousglass-preform, asbestos, sisal.
Number and sizes of preformers: 48" preform machine.

Type of fabrication: aircraft ducting, aircraft structural & non-structural, reinforced plastic parts, photographic accessories (trays, sinks, etc.).
Pres. & Sales Mgr.—Felix M. Farrell
V. Pres.—Joe H. Yeager
Pur. Agt.—John W. Hickman

KENTUCKY

Production Aid, Inc., Middletown
Type of resins and reinforcements used: epoxy, glass, asbestos, silica, metallic powders.
Type of fabrication: wet lay-up casting machining.
Pres.—T. E. Vassar
V. Pres.—J. S. Sutherland

MARYLAND

Artmor Plastics Corp., Cumberland
Types of Molding done: architectural panels & components via matched metal dies.
Presses: 3-Approx. 36 x 48, 20" daylight
Type of resins and reinforcements used: polyester, acrylic, with fibrousglass, orlon, other synthetics
Personnel: see p. 1103

Chance, W. R., & Associates, Inc., Waldorf
Types of molding: vacuum molding & open molding.
Type of resins and reinforcements used: polyester & epoxy resins, glass reinforcement.
Type of fabrication: development prototypes and production of large structures.
Pres.—W. R. Chance
Treas.—J. R. Riggleman, Jr.
Sales Mgr.—D. P. Hains
Secy.—Miss R. Wittschiebe

MASSACHUSETTS

Beetle, Carl N., Plastics Corp., Fall River
Types of molding done: hand lay-up, bag molding, matched metal plaster, wood, plastic, metal.
Type of resins and reinforcements used: polyester, epoxy glass, nylon, sisal etc.
Type of fabrication: tanks, stacks, ducting, radomes, vents, hoods and housings.

Church, C. F., Division of American Standard, Holyoke.
Types of molding done: matched metal molds in hydraulic presses.
Presses: 1-100 ton, 48 x 48 x 48" stroke, 1-80 ton, 24 x 24 x 16" stroke.
Type of resins and reinforcements used: polyesters, epoxy, fibre glass, sisal.
Number and sizes of preformers: 1-double 36"
Type of fabrication: hand lay-up.
Pres.—R. A. Witherell
V. Pres.—S. L. Young
Sales Mgr.—R. Kolstad
Pur. Agt.—L. Shaw

Emerson & Cuming, Inc., Canton
Types of molding done: matched mold, vacuum bag.
Presses: 4
Size of flat laminate sheet: on special order only.
Type of resins and reinforcements used: polyester, epoxy, fibrous-glass cloth, mat.
Type of fabrication: for electronics industry.
Pres.—C. L. Emerson, Jr.
V. Pres.—W. R. Cuming
Sales Mgr.—E. W. Anderson
Pur. Agt.—John F. O'Brien

Jupiter Plastics, Inc., Pittsfield
Types of molding done: lay-up
Pres.—Daniel C. Hurlbut
V. Pres. & Sls. Mgr.—Joseph Hines
Pur. Agt. & Treas.—Norman J Shalett

Laminated Sheet Products Corp., Norwood
Type of fabrication: machining, engraving, forming, marking.
Personnel: see p. 1091

McMillan Industrial Corp., Ipswich
Types of molding done: low pressure laminate radomes & custom shapes, cast aluminum molds.
Size of flat laminate sheet: 4' x 8'
Type of resins and reinforcements used: polyester, epoxy, phenolic, glass mat, fibrousglass cloth.
Type of fabrication: radomes, tubes, rods, sheets custom shapes, insulated panels (foam sandwich).
Pres.—Edward B. McMillan
Sales Mgr.—Arthur M. Brink
Pur. Agt.—A. Clark

●**Sandman, Eli, Co.,** Worcester
Continuous Laminating: on fibrous-glass, cotton, cloth, paper and all synthetic fabrics.
Type of resins and reinforcements used: phenolics, epoxies, polyesters and vinyls.
Type of fabrication: impregnating and coating.
Personnel: see p. 1106

Trimount Plastic Co. Inc., Arlington
Presses: 4 presses-1-10 x 10 x 12"; 2-24 x 54 x 30"; 1-54 x 112 x 36".
Size of flat laminate sheet: 24 x 38, 54 x 112, 24 x 54.
Type of resins and reinforcements used: epoxy, glass, cloth, laminates, copper clad & unclad.
Personnel: see p. 1091

MICHIGAN

Ameriplastic Company, Flint
Types of molding done: hand lay-up, wood, plaster, metal and plastic molds.
Type of resins and reinforcements used: polyester, epoxy, glass, sisal.
Type of fabrication: custom
Personnel: see p. 1079

Duralastic Products Co., Detroit
Types of molding done: mat laminates, premix molding.
Presses: 20- maximum size, 36" x 72" x 30" strokes up to 150 tons; platen up to 48" x 72", daylight 48", strokes 36".
Size of flat laminate sheet: 3' x 6.
Type of resins and reinforcements used: polyester, phenolic, epoxy glass, sisal.
Type of fabrication: riveting, stapling.
Pres.—Joseph N. Epel
V. Pres.—Julius Barach
Sales Mgr.—Joseph N. Epel
Pur. Agt.—James R. Pollock

●**Fabricon Products, Div. of Eagle-Picher Co.,** River Rouge
Types of molding done: compression molding-reinforced plastics.

●Indicates Advertiser.

Presses: Up to 42 x 60, max. daylight 65".
Type of resins and reinforcements used: polyester resins, fibrous-glass and sisal reinforcements.
Number and sizes of preformers: 1–48" x 48".
Personnel: see p. 1080

Harstil Industries Co., St. Clair Shore
Types of molding done: specialize in laminated rolled tubing and contact molding of large custom parts.
Type of resins and reinforcements used: epoxy and polyester, resins, glass cloth or mat as required.
Type of fabrication: laminated tubing, contact molding of stock 24' cruisers, low production using matched plastic molds.
Personnel: see p. 1092

Haskelite Mfg. Corp., Grand Rapids.
Size of flat laminate sheet: 48 x 144
Continuous laminating: .018 & .032 glass.
Type of resins and reinforcements used: polyester resin.
Personnel: see p. 1092

Michigan Fiberglas Sales, E. Detroit
Types of molding done: hand lay-up, plaster & fibrous-glass.
Type of resins and reinforcements used: polyester & epoxy.
Type of fabrication: prototype & products.
Pres. & Sales Mgr.—E. D. Ireson, Jr.
V. Pres. & Pur. Agt.—Julian F. Ireson

Morrell, George, Corporation, Muskegon Heights
Types of molding done: compression and transfer molding.
Type of resins and reinforcements used: polyester, epoxies, fibrous-glass, asbestos, sisal.
Pres.—John Reardan
V. Pres. & Pur. Agt.—Albert Lyonnais
Sales Mgr.—C. Joseph Kaskie

Plastic Masters, Inc., New Buffalo
Number and sizes of preformers: 1–80 tons, 1–60 tons, 1–35 tons.
Pres.—Victor A. Miller
V. Pres.—Owen E. Skelton
Gen. Mgr.—Carl G. Marquardt
Sales Mgr.—Richard P. Smith
Pur. Agt.—Bernard A. Guerrettaz

Reynolds Plastics, Inc., Walled Lake
Types of molding done: steel, aluminum, epoxy.
Presses: 2–26" x 24" x 18" opening, 12" x 18" x 11" opening.
Type of resins and reinforcements used: polyester and epoxy.
Type of fabrication: custom and production.
Personnel: see p. 1092

MINNESOTA

●**Northwest Plastics, Inc.,** St. Paul
Types of molding done: compression, steel, hand lay-up, epoxy.
Presses: same as compression.
Type of resins and reinforcements used: epoxy, polyester, glass.
Type of fabrication: largely hand lay-up.
Pres.—J. R. Frevermuth
V. Pres. & Chief Engr.—W. H. Mahle
Sales Mgr.—F. T. Thiets
Pur. Agt.—R. J. Twiss

Sperzel Co., Minneapolis
Presses: 4–42" x 36"
Pres. & Pur. Agt.—M. J. McCabe
V. Pres.—A. Deinard
Sales Mgr.—H. H. Reinhard

MISSOURI

Hanley Plastics Company, St. Louis
Types of molding done: hand lay-ups, matched metal die, etc. Steel, plaster, epoxy, etc.
Presses: 1 compression press, 18" x 22" bed, 22 ton, daylight 15"; misc. presses.
Size of flat laminate sheet: Laboratory: 10" x 8"
Type of resins and reinforcements used: fibrous-glass reinforced polyester, fibrous-glass reinforced epoxy, and isocynate foams.
Type of fabrication: product development and pilot runs by compression moulding, hand lay-ups etc.

Kelley, George A., Fredericktown
Type of fabrication: centerless grinding screw machine parts formed extrusions punching etc.
Personnel: see p. 1092

Kopplin Molding Corp., St. Louis
Types of molding done: polyester, glass
Presses: 8–75 to 200 ton, 20–36" daylight

Regal Plastic Co., Kansas City
Type of molding done: bag molding, hand lay-up, gunk, matched metal dies.
Presses: 3 Hydraulic presses: 48 x 42, 72" daylight; 30" x 30", 72" daylight; 18" x 16", 24" daylight.
Type of resins and reinforcements used: polyester, fibrous-glass, epoxy, sisal.
Number and sizes of preformers: 1–48" preformer.
Type of fabrication: all kinds.
Pres., Chairman of Board of Directors & Sales Mgr.—J. S. Kivett
V. Pres. & Chief Engr.—N. D. Gallagher
Asst. Sales Mgr.—W. L. Short
Pur. Agt.—Paul E. Snow

NEBRASKA

Kerr, R. W., Plastic Co., Hastings
Types of molding done: matched metal molds.
Presses: 3-up to 35" x 46" platen size with 16" stroke.
Size of flat laminate sheet: 18" x 24" thermoplastic
Type of resins and reinforcements used: most all types.
Type of fabrication: most all types.
Personnel: see p. 1092

Kerrco Products, Lincoln
Types of molding done: Matched steel molds
Presses: 3-up to 35" x 46", 26" daylight opening.
Type of resins and reinforcements used: polyesters and epoxies, glass and sisal.
Type of fabrication: all types.
Personnel: see p. 1092

Omaha Plastics Co., Omaha
Types of molding done: expoy casting, aluminum molds.
Type of resins and reinforcements used: epoxy, fibrous-glass, cloths, mats and dacron.
Pres. & Pur. Agt.—George D. Kahn
V. Pres.—Jewel K. Kahn

NEW HAMPSHIRE

Keller Products, Inc., Manchester
Types of molding done: fabricator.
Continuous Laminating: 4' x 10'.
Types of resins and reinforcements used: polyesters.
Type of fabrication: laminating large building panels.
Personnel: see p. 1092

NEW JERSEY

American Molded Fiberglass Co., Paterson
Types of molding done: hand open lay-up of large parts on fibrous-glass reinforced plastic molds; vacuum & match metal molding.
Presses: 3 presses (2–6' x 1'–2' daylight); (1 2' x 2'–2' daylight)
Type of resins and reinforcements used: polyester, epoxy with fibrous-glass, cotton, asbestos and sisal fibre.
Type of fabrication: all types of fabrication, specialize in large parts.
Pres.—S. Quentzel
Secy. & V. Pres.—H. Quentzel

Carpenter, L. E., & Co., Wharton
Continuous laminating: 56" finished width thickness-various.
Type of resins and reinforcements used: polyvinyl chloride.
Type of fabrication: conversion.
Pres.—George Lucas, Jr.
V. Pres.—J. V. Medici
Sales Mgr.—John Foster
Pur. Agt.—Arthur W. Mitchell

Electronic Mechanics, Inc., Clifton
Types of molding done: compression on glass bonded mica steel; both laminate and custom molding.
Size of flat laminate sheet: 14" x 19", 19 x 29.
Type of fabrication: complete machine shop for all types fabrication on glass bonded mica.
Pres.—D. E. Replogle
Treas. & Pur. Agt.—N. E. Brown
Sales Mgr.—J. E. Nester

Gemar Mfg. Co., Inc., Linden
Continuous laminating: 54" with 0005 to 030 paper, cloth plastics.

Hunter Plastics Co., Englewood
Type of fabrication: thermo plastic only.
Pres. & Sales Mgr.—Charles H. Hunter
V. Pres.—Frank J. Van Segvelt
Pur. Agt.—Frank J. Van Segvelt

Jersey Plastic & Die Casting Co., Irvington
Types of molding done: fibrous-glass reinforced polyester
Pres.—Patrick B. Zazzara
Gen. Mgr.—Nicholas L. Zazzara
Sales Mgr.—Berkeley A. Cater
Pur. Agt.—Jos. Circhirillo

Plastic Laminating Corp., Vaux Hall
Presses: 2–24 x 26, 1–24 x 54, 1–38 x 48.
Size of flat laminate sheet: 24 x 26, 24 x 31, 24 x 42, 24 x 48, 24 x 54, 38 x 48.
Personnel: see p. 1092

●**Polyplastex United, Inc.,** Union
Presses: 1 press; platen area–48" x 96"; daylight space 3".
Size of flat laminate sheet: 48" x 96".
Continuous laminating: width 60", thickness .025" use paper, glass & cloth.
Personnel: see p. 1106

● Indicates Advertiser.

Spiral Glas Pipe Co., New Brunswick
Continuous laminating: continuous pipe laminating.
Types of resins and reinforcements used: fibrous-glass reinforced DAP polyesters.
Type of fabrication: tubular goods.
Personnel: see p. 1092

Springfield Fabrications, Inc., Springfield
Type of fabrication: thermoplastic components made to customers' specifications.
Pres.—Henry F. Colvin
V. Pres.—Esther F. Colvin
Secy.—Treas.—Samuel H. Friedman
Pur. Agt.—J. F. Sweeney

Winner Mfg. Co., Inc., Trenton
Molding: Matched die, pressure bag, vacuum; molding on steel, alum, plastic dies.
Type of resins and reinforcements: glass, vegetable, synthetic with polyester and epoxy.
Number and size of preformer: 1-48"
Fabrication: all
Pres.—I. M. Scott
V. Pres.—H. L. Darby and J. Rosenwald II
Pur. Agt.—D. A. White

NEW YORK

DuBois Plastic Products, Inc., Buffalo
Types of molding done: custom molding, premix materials, matched metal molds.
Presses: 1-48" x 84" x 53" daylight, 1-44" x 46" x 39" daylight, 1-40" x 40" x 40" daylight, 1-36" x 43" x 38¼" daylight, 1-24" x 24" x 36" daylight, 1-20" x 20" x 30" daylight. Total 6 presses.
Pres.—N. J. Taylor
V. Pres. & Gen. Mgr.—R. A. Bright
Sales Mgr.—J. H. Ehrhardt
V. Pres.—W. F. Sterne
Pur. Agt. & Asst. Gen. Mgr.—R. V. Shear

Durable Formed Products, Inc., New York
Types of molding done: pre-impregnated fibrous-glas, low pressure molding.
Presses: 3 presses, size of platen 36" x 36", stroke 18"
Pres.—Vito A. Tanzi
V. Pres.—Robert A. Gerardi
Sales Mgr.—Allan M. Selig
Pur. Agt.—Thomas McManus

Emerson Plastics Corp., Bronx
Type of fabrication: precision fabricator of all plastic materials.
Pres.—W. Elsfelder
V. Pres.—I. Elsfelder
Sales Mgr.—A. Margosian
Pur. Agt.—D. Singer

Fairchild Guided Missiles Div., Fairchild Engine & Airplane Corp., Wyandanch
Types of molding done: vacuum bag, autoclave, matched die, mandrel winding and premix.
Presses: (7) presses-maximum size 84" x 48" x 56" daylight, 250 tons with heated platens.
Size of flat laminate sheet: Up to 48" x 84".

Type of resins and reinforcements used: polyester, epoxy, & phenolic resins with glass fabrics, mats rovings & chopped fibers.
Type of fabrication: missile and aircraft structural components, containers, and pressure vessels.
Gen. Mgr.—E. A. Speakman
Pur. Agt.—G. J. Ryan
Mgr. Plastics—C. R. Lemonier

American Combining Corp., Rockaway Beach (New Jersey)
Continuous laminating: 20 Mil., cloth.
Type of resins and reinforcements used: vinyl, cellulose.
Personnel: see p. 1106

American Hard Rubber Co., New York
Types of molding done: preform molding, quick molding matched metal steel molds.
Presses: see compression press equipment list.
Type of resins and reinforcements used: glass and cellulosic fibers polyester and phenolics.
Number of preformers: 3 large
Type of fabrication: all normal punching cementing and assembly operations.
Pres.—V. T. Norton
V. Pres. & Sales—Roland Reppert
Pur. Agt.—V. E. Culver

Atlas Plastics, Inc., Buffalo
Types of molding done: contact mandrel wrap, vacuum bag & matched die molding; plaster, wood aluminum and steel molds.
Presses: 6 up to 24" x 24", 20" daylight.
Size of flat laminate sheet made, if any: 24 x 24
Type of resins and reinforcements used: polyester & epoxy (resins), glass fabric, mat and rovings, (reinforcement).
Pres.—H. S. Nathan
V. Pres.—J. H. Nathan
Sales Mgr.—D. L. Thomas

Castle Plastics, Inc., New York
Number and size preformers: 2 stokes model T
Pres. & Sales Mgr.—C. V. Flynn

Cheslam Corporation, Yonkers
Continuous laminating: paper 40" wide, cellophane 40" wide.

Du Verre, Inc., Buffalo
Types of molding done: Tubes, special shapes.
Types of resins and reinforcements used: polyester, epoxy resins, fibrous-glass, Synthetic fiber reinforcements.
Type of fabrication: custom fabrication of duct systems, hoods, tanks, special shapes.
Personnel: see p. 1092

Glasply Corp., Mount Vernon
Types of molding done: convolute tubing-matched dies hand lay-up bag molding.
Presses: 1-18" x 24" press.
Size of flat laminate sheet: 58" max. width x 20 ft. max. length.
Types of resins and reinforcements used: polyester, epoxy, fibrous-glass, paper, premix.
Type of fabrication: machining & assembly to close tolerances.
Personnel: see p. 1092

Herblin Corp., Glen Cove
Types of molding done: hand lay-up. vacuum bag, press fiber glass, epoxy, Aluminum.
Presses: 6-24 x 36, 48 daylight.
Type of resins and reinforcements used: epoxy Polyester, glass, orlon, dacron, sisal.
Type of fabrication: protypes-production runs radomes, boats etc.; specialize in large items.
Pres. & Pur. Agt.—G. B. Herblin
V. Pres.—C. V. Herblin
Sales Mgr.—W. L. Herblin

●**Insulation Manufacturing Co., Inc.,** Brooklyn
Types of molding done: compression & transfer hand, semi-auto and automatic.
Size of flat laminate sheet: 18" x 24" school desk tops melamine surface

Marbek, Inc., Brooklyn
Continuous Laminating: cloth and paper all widths up to about 57" all thicknesses.
Personnel: see p. 1106

Plastic Center, Rochester
Type of fabrication: plexiglas & phenolic fabrication.
Personnel: see p. 1093

Plasti-Vue, Whitestone
Type of fabrication: vacuum forming, blowing, drawing precision machining, forming of sheets.

Rudd Plastic Fabrics Corp., Brooklyn
Types of molding done: press polishing.
Size of flat laminate sheet: 24" x 54"
Continuous laminating: cloth & paper to vinyl 54" wide up to 40 gauge.
Type of resins and reinforcements used: vinyl chloride, styrene copolymers.
Type of fabrication: calendering laminating, embossing, & press polishing and printing
Personnel: see p. 1106

Scheri Process Division of Ferro-co. Corp., Long Island City
Types of molding done: wet lay-up on male or female molds of wood, plaster, metal, reinforced polyester.
Size of flat laminate sheet: 50" x 152" any thickness.
Continuous laminating: 44" wide up to 1/16" thick paper, glass, or cloth.
Type of resins and reinforcements used: polyester & epoxy resins, glass, dynel, cotton, etc.
Type of fabrication: reinforced plastics, wet lay-up and secondary bonding.
Pres.—Kenneth Carroad
V. Pres.—Gunhilde Carroad
Sales Mgr.—Bernard Goldberg
Pur. Agt. & Plant Mgr.—Morton J. Gurdin

Silicone Insulation, Inc., Bronx
Types of molding done: matched metal molding of insulating & other shapes.
Presses: 20 to 40" x 40"
Size of flat laminate sheet: 36" x 36".
Type of resins and reinforcements used: silicone, polyester, epoxy, melamine, phenolic glass cloth Mat, glass fibres.
Type of fabrication: insulating shapes, slot wedges, coil bobbins, core tubes and parts to print.
Pres.—W. Elsfelder
V. Pres. & Sales Mgr.—A. Margosian
Pur. Agt.—D. Singer

Starlite Plastic Co., Kenmore
Types of molding done: compression & hand lay-up plastic plaster & steel mold.
Presses: 3-36" x 72"

●Indicates Advertiser.

Type of resins and reinforcements used: polyester resin, glass flock reinforcement.
Pres.—A. Bonk
V. Pres.—S. Bonk
Sales Mgr. & Pur. Agt.—S. Weir

Superior Laminating Co., New York
Presses: 1 Press 6 x 9 platen, Daylight space 1" on each of 2 platens
Size of flat laminate sheet: 5" x 8"
Type of fabrication: Acrylic-sanding, polishing, drilling, laminating, cutting, spindle carving, internal carving
Personnel: see p. 1093

Syracuse Ornamental Co., Syracuse
Types of molding done: compression matched & metal molds.
Type of resins and reinforcements used: polyester, glass.
Number and sizes of preformers: 1-3 ft. Dia.
Pres.—A. E. Holstein
V. Pres.—P. M. Holstein
Sales Mgr.—R. A. Holstein
Pur. Agt.—M. F. Clark

Syracuse Plastic Molders, Syracuse
Type of fabrication: vacuum forming 1-48" x 96" twin table vacuum forming 1-36" x 24" single.
Pres.—Joseph R. Falcone
V. Pres.—Anthony Falcone, Jr.

TMC Industrial Corp., Mamaroneck
Types of molding done: low and contact pressure, using aluminum, plastic, wood & plaster molds; vacuum bag mold molding; hand lay-up molding.
Type of resins and reinforcements used: polyester, epoxy, glass fiber rovings: mat, and glass cloth.
Type of fabrication: development-prototypes & production of all size products.
Pres. & V. Pres.—W. L. Deans
Pur. Agt.—T. McWaters, Jr.
Mgr. Plastic Div.—A. Mills

United Mask & Nov. Co. Inc., Glendale
Type of fabrication: vacuum forming: 8 machines up to 48 x 96"
Pres.—Elwood Pamatat
V. Pres., Sales Mgr. & Pur. Agt.—Clinton Pamatat

NORTH CAROLINA

Southern Plastics Engineering Corp., Greensboro
Number and sizes of performers: 1—12 ton.

OHIO

Armored Plastics Co., Div. of Globe Wernicke Industries, Inc., Toledo
Type of molding done: mat & preformed molded parts in matched metal molds.
Presses: 1-60" + 84", 4' strokes, 84" daylight, 2-60" + 42", 4' strokes, 7' daylight.
Types of resins and reinforcements used: glass fibers.
Preformers: 2-4", 1-36"
Type of fabrication: molded parts, punch, press & assembly.
Pres.—Wm. D. Hohn
Exec. V. Pres.—Joseph F. Howard
Mgr., Plastics Div.—Robert S. Beverlin
Sec.—Wayne H. Patterson
Pur. Agt.—Walter J. Todd

●Indicates Advertiser.

●**Barren. J. E., Plastics, Inc.,** Cincinnati
No. of Presses, platen area, daylight space: 2 presses, 20x42 area, 2" daylight.
6 platens in one press, 8 in the other.
Size of Lam. Sheet: 20x24.
Resins and reinforcements used: butyrate, wire reinforced.

Baxter Co., Cincinnati
Type of fabrication: acrylic, vinyl acetate co polymer, polyethelene.
Pres. & Treas.—J. E. Baxter
V. Pres. & Secy.—Robert Stern
Pur. Agt.—John Helgesen

Cincinnati Development & Mfg. Co., Cincinnati
Presses: 1-50 ton, 1-30 ton.
Size of flat laminate sheet: 24" x 38", 10½" x 36".
Type of resins and reinforcements used: fibrous-glass, polyester resin.
Type of fabrication: stamping, shearing, drilling, sawing, grinding, milling.
Pres. William H. Mooney
Exec. V. Pres. & Sales Mgr.—William M. Mooney
Pur. Agt.—Edmund D. Mooney

Francis Industries, Pataskala
Types of molding done: press, wet lay-up, premix.
Presses: 6 presses, to 50 tons, special design.
Type of resins and reinforcements used: epoxy, polyester, alkyd, phenolic, glass, nylon.
Type of fabrication: as required.

●**General Tire and Rubber Co.,** Akron
Types of molding done: matched metal molds
Presses: 50 presses: 30" x 30" up to 48" x 108", up to 30" daylight.
Type of resins and reinforcements used: polyester, epoxy, glass, sisal.
Number of sizes of preformers: 5 up to very large.
Type of fabrication: custom
Personnel: see p. 1085

Glastic Corp., Cleveland
Types of molding done: flat sheet and premix.
Presses: 12
Size of flat laminates sheet: 36 x 72".
Type of resins and reinforcements used: polyester, fibrous-glass.

Greene, Ray, & Company, Toledo
Presses: 3-18 x 80, 16 x 16, 12 x 48.
Types of resins and reinforcements used: polyester & epoxy glass & asbestos.
Type of fabrication:
Large objects. (Boats etc. to 40').
Personnel: see p. 1093

Heil Process Equipment Corp., Cleveland
Size of flat laminate sheet: 36" x 96", 48" x 96".
Type of resins and reinforcements used: polyester, glass epoxy glass.
Type of fabrication: industrial equipment ventilating ducts, tanks, trays.
Pres.—C. E. Heil
V. Pres.—E. W. Vereeke
Sls. Mgr.—D. E. Holmgren
Pur. Agt.—G. C. King

Plastic Parts Corp., Maumee
Types of molding done: matched die and vacuum bag, using plastic or metal dies.
Pres.—W. F. Broer, Jr.
V. Pres.—D. L. Lambert, Jr.

Plastic Products Corp., Bedford Heights
Types of molding done: custom molding, matched metal.
Presses: 2 presses with 20" x 20" platen, 18" daylight: 2 with 30" x 36" platen, 30" daylight: 2 with 50" x 50" platen, 36" daylight.
Type of resins and reinforcements used: polyester resin, fiberglass reinforcement.
Number and sizes of preformers: 1-36" preformer, 1-48" preformer, 1-54" preformer.
Personnel: see p. 1105

●**Plastic Research Products,** Div. of **Grimes Mfg. Co.,** Urbana
Types of molding done: compression and transfer.
Presses: 50
Types of resins and reinforcements used: prepared molding compounds (plaskon, Esterine, Glaskyd, etc.)
Number and sizes of preformers: 6 preformers up to 50 ton.
Personnel: see p. 1086

●**Structurlite Plastics Corp.,** Hebron
Types of molding done: glass reinforced plastics, preform, premix and silicone.
Presses: 16 presses: ranging from 25 to 500 ton cap. with platen areas from 2' up to 6' x 6'. Daylight space from 24" to 94".
Type of resins and reinforcements used: polyester and silicone resins. Glass roving and mat.
Number and sizes of preformers: 1-24" automatic, 1-30" automatic, 1-6" dia. turntable and 4-30" dia. turntable.
Type of fabrication: punching, cementing and assembly.
Pres.—Charles D. Jones
V. Pres. & Sales Mgr.—Robert E. Griffith
Pur. Agt.—L. R. Rose

OKLAHOMA

Fibercast Corp., Sand Springs
Types of molding done: pipe fittings, matched die molding, epoxey & polyestine, molding gunks.
Presses: 3-25 ton each, 18" x 18" x 18".
Type of resins and reinforcements used: epoxy, resins and hardners, glass fibers.
Type of fabrication: patented centrefugal casting of pipe & tube 2 3/8" OD, 2 7/8" O. D., 3½" O. D. x 21' lengths. Pipe fabrication to suit.
Pres.—George McCuskey
V. Pres.—Dr. Karl Fetters
Sales Mgr.—Jerry Hutchison
Pur. Agt.—Jack Woods

PENNSYLVANIA

●**American Insulator Corp.,** New Freedom
Types of molding done: press molding, vacuum bag molding, hand lay-up, pre-mix molding-matched metal, single member sheet metal, wood plastic molds.

Presses: 1-40 ton 48" x 72" platen, 72" daylight, 1-80 ton 48" x 78" platen, 72" daylight, 1-100 ton 48" x 48" platen, 108" daylight, 1 turner preformer.
Size of flat laminate sheet made: 36" x 52" in thickness from ¼" to ½".
Types of resin used: polyester, epoxy fiberglass chopped strands, roving, mat, woven cloths, sisal chopped fibers.
Number and size of preformers: 1 turner preformers.
Type of fabrication you do: sawing, routing, grinding, drilling, rivetted and bonded assemblies, silk screening and spray painters.
Personnel: see p. 1087

•Consolidated Molded Products Corp., Scranton
Types of molding: reinforced glass fiber, steel and aluminum matched metal molds.
Presses: 8 low pressure presses up to 200 tons: up to 60" x 84" platen: 84" daylight.
Personnel: see p. 1087

Curry Arts Molding & Laminating Co., Scranton
Types of molding done: compression molding, chromium plated stainless steel molds.
Presses: One; area 36" x 38", 4 openings, 3½" daylight ea. opening.
Size of flat laminated sheet: 21 x 25½".
Type of fabrication: forming, machining, assembling, etc.
Personnel: see p. 1087

•Erie Plastics Co., Div. of Erie Iron & Supply Corp., Erie
Presses: 1-4½", 1-2", 1-3¼
Type of fabrication: reprocessing and pelletizing of thermoplastic materials; also custom extrusion.
Pres., Sales Mgr. & Pur. Agt.—Edward A. Zacks

Halsey, Inc., Scranton
Types of molding done: compression & transfer.
Pres., Sls. Mgr. & Pur. Agt.—Halsey J. Sorrell
V. Pres.—C. W. Hupfer

Hays Mfg. Co., Erie
Types of molding done: compression.
Size of flat laminate sheet: 36" x 48".
Type of resins and reinforcements used: (polyester, phenolic, epoxy) glass, cloth, etc.
Pres.—W. H. Forster
V. Pres.—J. D. Clemens
Sls. Mgr.—H. H. Clemens

McClarin Plastics, New Oxford
Types of molding done: low pressure laminates hand lay-up.
Type of resins and reinforcements used: polyester resin, glass reinforcement.
Type of fabrication: products from plexiglas.
Pres. & Pur. Agt.—C. G. McClarin
V. Pres. & Sales Mgr.—R. G. Meckley

Mechtronics, Philadelphia
Types of molding done: hand lay-up & Vacuum Bag
Size of flat laminate sheet: 4 x 12 ft.

Type of resins and reinforcements used: polyester, epoxy, resins, glass & misc. reinf.
Pres.—Semond Levitt

Molded Fiber Glass Tray Co., Linesville
Types of molding done: compression molding matched metal molds.
Presses: 14 presses: 1-40" x 48", 61" daylight: 9-32" x 36, 38" daylight: 4-20" x 20", 28" daylight.
Types of resins and reinforcements used: polyester resin, fiberous-glass & sisal reinforcements.
Type of fabrication: materials handling trays, boxes, wire spools and pallets.
Pres. & Pur. Agt.—A. W. Levenhagen
V. Pres. & Sales Mgr.—J. W. Moore

• Perry Plastics, Inc., Erie
Types of molding done: steel and aluminum molds, pre-mix and mat molding.
Presses: 1-36" x 24", 24" daylight: 1-24" x 20", 20" daylight: 1-48" x 48", 30" daylight.
Size of flat laminate sheet: 48 x 48
Type of resins and reinforcements used: polyester, phenolic resins, fiberous-glass and sisal reinforcements.
Pres.—Jerry V. Stokes
V. Pres. & Treas.—H. H. George
Sales Mgr.—S. C. Seley
Pur. Agt.—H. K. Siegmund

Raybestos-Manhattan, Inc., Reinforced Plastics Dept., Manheim
Types of molding done: compression molding using matched metal molds.
Presses: variety of presses ranging from 6" x 6" up to 3 ft. x 3 ft. with 3 ft. daylight space.
Type of resins and reinforcements used: asbestos & glass reinforcements with phenolic, silicone, epoxy and polyester.
Type of fabrication: flat to complex parts where high strength and extreme heat resistance are required.
Pres.—J. F. D. Rohrbach
V. Pres.—O. H. Cilley
Product Mgr.—D. V. Rosato
Pur. Agt.—W. R. Bitzer

Resolite Corporation, Zelienople
Types of molding done: low pressure, corrugated Al molds.
Size of flat laminate sheet: max. size 42" x 12'.
Type of resins and reinforcements used: polyester and fiberous-glass mat.
Type of fabrication: polyester fiberous-glass reinforced translucent sheets.
Pres.—Elwin G. Smith
Exec. V. Pres.—Kenneth H. Beer
Sales Mgr.—Bernard E. Magette
Pur. Agt.—Joseph Morgan

• Scranton Plastic Laminating Corp., Scranton
Presses: 20" x 25; 36" x 48"; 50" x 108".
Size of flat laminate sheet: same as press sizes above.
Type of resins and reinforcements used: vinylite, acetate, butyrate, polyethylene, acrylic, PVC and styrene. Glass etc.
Personnel: see p. 1107

Sealview Plastics, Inc., Wayne
Types of molding done: custom molding, press, bag and hand lay-up.
Presses: 3-100 ton, 30 x 40 platen, 60" daylight: 1-100 ton, 38 x 72, 10" daylight; 1-50 ton, 30 x 30, 40" daylight.
Size of flat laminate sheet: up to 38" x 120".
Type of resins and reinforcements used: polyesters and epoxies.
Number and sizes of preformers: 1-4' x 5', 1-6' x 6'.
Type of fabrication: corrugated step-lap, decorative architectural, large small-run structures, prototypes
Pres.-Robert C. Watson
V. Pres. & Treas.—High H. Aiken

Strick Plastics, Perkosie
Types of molding done: compression, hand lay-up.
Presses: 1-65" x 105", 14"; 2-12" x 12", 20"; 1-18" x 116", 24"
Size of flat laminate sheet: 50" x 100" thickness 1/32 to 2".
Type of resins and reinforcements used: polyester resins, glass cloth & glass mat.
Type of fabrication: punch, shear, drill, rout, grind.
Personnel: see p. 1093

Synthane Corp., Oaks
Types of molding done: compression.
Presses: Over 50 of many sizes & types.
Size of flat laminate sheet: 005" to 8" thick, 36" x 36", 72" x 36", 96" x 24".
Types of resins and reinforcements used: phenolics, melamine, epon-silicone, dap cellulose paper & fabric-glass, fabric glass mat, cotton mat, asbestos paper and fabric, orlon, nylon fabrics.
Number and sizes of preformers L 2
Type of fabrication: complete facilities for complete fabrication service
Personnel: see p. 1093

Washington Plastics Co., Sharon
Presses: 1.
Size of flat laminate sheets: 8 x 10.
Whether glass, paper or cloth, paper-cloth, etc.
Type of laminating: pictures on wood or paper, etc.
Personnel: see p. 1093

RHODE ISLAND

Anchorage Plastics, Inc., Warren
Types of molding done: fiberglass prepreg. mat and cloth polyester.
Presses: 30 x 36 platen, 50 ton 2 ft. daylight adjustable pyrometer heat control electric heater steel molds.
Type of resins and reinforcements used: mat pre-preg and glass cloth polyester resins.
Type of fabrication: hand lay-up and compression also vac press molding.
Personnel: see p. 1088

TENNESSEE

National Plastics, Inc., Knoxville
Types of molding done: reinforced preimpregnated glass mat with matched molds.
Presses: 2-26" front to back, 31" left to right, 47" daylight; 2-25" front to back, 26" left to right 36" daylight; 2-24" front to back, 25" left to right 24" daylight.
Pres.—Chris Van Deventer, III
V. Pres. in charge of Sales—Charles L. Yeomans
V. Pres. in charge of operations—M. T. Victor

•Indicates Advertiser.

TEXAS

Lone Star Plastics Co. Inc., Fort Worth
Types of molding done: high and low pressure matched die molding, bag molding, contact lay-up. All type molds used.
Presses: 1-30" x 48" x 18"; 1-12" x 18" x 18"; 1-40" x 60" x 14"; 1-12" x 15" x 18"; 1-24" x 24" x 20"; 2-8" x 10" x 10".
Size of flat laminate sheet: 48" x 144".
Type of resins and reinforcements used: polyester & epon resins with fibrous-glass; also silicone & resins & silastic.
Type of fabrication: do all types low pressure bag or contact molding with wet lay-up or preimpregnated materials. Specialize in industrial applications.
Pres.—Melvin Hare
V. Pres.—E. H. Swazey

Polymer Engineering Corp., Houston
Types of fabrication: contact pressure and bag molded laminates with polyester and epoxy resins, glass and other reinforcements.
Pres.—John Belding
Vice Pres. & Gen. Mgr.—R. P. Bailey
Sec. & Treas.—R. H. Hughes
Pur. Agt.—Alexander Brown

Texas Glass Fiber Corp., Grandview
Types of molding done: boat hulls, hand lay-up, plastic molds.
Type of resins and reinforcements used: polyester, glass fiber.
Pres.—W. E. Hutton-Miller
V. Pres.—Charles E. Martens
Pur. Agt.—W. C. Ward

VERMONT

Newport Plastics Corporation, Newport
Types of molding done: low pressure with special collapsible molds of metal, plastic etc.
Presses: 17 special designed presses.
Type of resins and reinforcements used: polyester, epoxies, and polyurethane.
Type of fabrication: insulated cold food containers for airlines.
Pres.—J. R. Audet
Pur. Agt.—Paul Beaudry & Lloyd Douglas

VIRGINIA

Hafleigh & Company, Buchanan
Types of molding done: steel-matched.
Type of resins and reinforcements used: polyesters.

Universal Moulded Products Corp., Bristol
Types of molding done: metal molds used autoclave molding, vacuum blanket molding, matched metal die molding, compression molding.
Presses: see compression presses in first column.
Type of resins and reinforcements used: polyesters, phenolics, silicones and epoxies, reinforcement; glass or asbestos fibers or cloth, and mats.
Number and sizes of preformers: 1-36", 1-72".
Type of fabrication: autoclave molding, vacuum blanket molding, matched metal die molding, compression molding, tube rolling, machining.
Personnel: see p. 1089

WASHINGTON

A & B Plastics, Seattle
Type of resins and reinforcements used: epoxy & polyester
Type of fabrication: custom body & boat repairs
Pres., Sales Mgr. & Pur. Agt.—C. A. Weaver, Jr.

Allied Mfg. Co., Seattle
Types of molding done: all types glass reinforced molding steel molds.
Presses: 2-300 T., 32" x 36" platen 24" daylight
Pres.—C. A. Stone
V. Pres. & Treas.—B. Wallace

Everlite Corp., Seattle
Types of molding done: continuous laminating, flat and corrugated, also special shapes.
Size of flat laminate sheet: 45" x 144".
Continuous laminating: 45" x ⅛" thick max. glass cloth & mat also special combinations.
Type of resins and reinforcements used: polyester glass-rayon, cloth paper.
Type of fabrication: proprietory skylites & suspended ceiling systems.
Pres.—Robert H. Anderson
V. Pres. & Pur. Agt.—Alva L. Strope
Sales Mgr.—Kenneth R. Anderson

Pacific Plastics Co. Inc., Seattle
Types of molding done: hand lay-up of duct of any shape
Presses: 28 x 28-4' daylight 100 ton; 36 x 40-5' daylight 150 ton; 48 x 96 - 200 ton; 6' daylight; 30 x 48-30" daylight 200 ton.
Size of flat laminate sheet: to order.
Continuous laminating: mfg. tank boats-printed circuits, etc.
Types of resins and reinforcements used: all types.
Number and sizes of preformers: can handle 48 x 48" x 48 preform.
Personnel: see p. 1089

WISCONSIN

Northern Plastics Corp., La Crosse
No. of presses, platen area, and daylight: 4 presses
Size of flat lam. sheets: 39" x 47", 39" x 41"
Whether paper, glass or cloth: all three.
Fabrication: all laminated and post formed laminated parts.
Sales Mgr.—Ray B. Haugen

Lewis, G. B., Company, Watertown
Types of molding done: matched metal dies of meehanite, forgings and tool steel, custom molding of preform and premixed parts.
Presses: 8 from 5 to 250 tons, up to 48" x 96", 84" daylight, 66" stroke.
Type of resins and reinforcements used: polyester and epoxy resins, glass fiber and asbestos reinforcements.
Number and sizes of preformers: 6
Type of fabrication: custom and proprietary products.
Pres.—G. Gordon Frater
V. Pres. & Sls. Mgr.—Milton A. Frater
Pur. Agt.—Arthur J. Killian

Weber Plastics, Inc., Stevens Point
Types of molding: expandable polystyrene, special molds designed for above process.
Presses: 1-24" x 24", 20" daylight, 1-10" x 20", 14" daylight
Pres.—E. C. Wotruba
V. Pres.—M. E. Sorensen

ENGLAND

●**Microcell, Ltd.,** London
Types of molding done: hand lay-up, rubber bag, matched tool.
Presses: 3 large, presses : 8' x 4' with 8' daylight.
Size of flat laminate sheet: up to 8' x 4'.
Continuous Laminating: 6' wide x 1/8" thick, glass fiber.
Type of resins and reinforcements used: polyester, epoxides, phenolic glass cloth, mats, asbestos, cellulonics.
Number and size of preformers: 3 up to 20 sq. ft. preform area.
Personnel: see p. 1094

PLASTIC SHEET FORMERS
(FORMING and DRAWING of THERMOPLASTICS)

CALIFORNIA

Art Plastics Mfg. Co., Los Angeles
Pres.—R. R. Connel
V. Pres.—Henry Connell
Sales Mgr.—Frank Brown

●Indicates Advertiser.

Blackman Plastics, Inc., Culver City
Pres.—Horace Blackman
V. Pres. & Pur. Agt.—Camille Castaing
Sales Mgr.—Earl Waynick

Chemtron Fiber Glass Co., El Monte,
Personnel: see p. 1090

Crowl, Charles, Company, El Monte
Pres. & Owner:—Charles A. Crowl
Sales Mgr.—Robert K. Buffington
Pur. Agt.—Jean R. Blakistone

Engineering Plastics Co., Pasadena
Owner & Sls. Mgr.—W. Kenneth Peasley
Pur. Agt.—Jay L. Weight

Complete addresses of companies listed appear on pp. 1123-1149

General Fibre Inc. Div. of General Plastics Corp., Los Angeles
Pres.—Fausto M. Ricci
V. Pres.—Joseph H. Kingsley

Pacific Plasti-Fab Corp., San Carlos
Pres.—F. A. Martin, Jr.
Sales Mgr.—John P. Slattery
Pur. Agt.—D. Bradley

Plastic Age Sales, Inc., San Fernando
Personnel: see p. 1090

Plastic Model Engineering Co., Van Nuys
Pres.—Edward F. Broeski
Secy.—Jane E. Broeski

Ray Products Co., Inc., Alhambra
Pres., Sales Mgr. & Pur. Agt.—A. A. Ray
V. Pres.—Margaret G. Ray

Revell Industrial Division, Venice
Engineer in Charge—Robert I. Bloom
Sales Engineer—Bernard Diggins
Pur. Agt.—Oliver Kimball

•**Swedlow Plastics Co.**, Los Angeles
Personnel: see p. 1090

•**Sierra Electric Corp.**, Gardena
Pres. & Sales Mgr.—Lee T. Bordner
V. Pres.—James C. Prior
Pur. Agt.—L. L. Landry

Urrite Plastics Fabricators, Pico
Personnel: see p. 1090

COLORADO

Pikes Peak Plastics, Inc., Colorado Springs
Pres.—Egon W. G. Wieselmann
V. Pres.—Florence E. Wieselmann

Plasticrafts, Inc., Denver
Personnel: see p. 1095

Reinhardt Plastic Company, Denver

CONNECTICUT

•**D & R Plastic Welders, Inc.**, Hazardville
Pres.—Henry M. Richardson
Treas.—John M. DeBell
Gen. Mgr.—Rolland C. Trudeau

Sealy Plastics Corp., Rockville
Pres.—Seymour E. Lavitt

Valley National Corp., Milldale
Pres. & Sales Mgr.—H. Reid Sterrett, Jr.
V. Pres.—W. J. B. Johnson
Pur. Agt.—W. J. B. Johnson

•**Watertown Mfg. Co.**, Watertown
Personnel: see p. 1076

FLORIDA

•**Modern Plastics**, Miami
Gen. Mgr. & Pur. Agt.—George H. Light
Sales Mgr. & Engr. Supervisor—Charles W. Manly

•Indicates Advertiser.

Plasti-Chemical Corp., Miami
Pres. & Pur. Agt.—Bailey M. Boggitt
Gen. Sales Mgr.—Geo. A. F. Schulte

Southern Plastic Products Co., Riviera Beach
Personnel: see p. 1096

GEORGIA

Gladwin Plastics, Inc., Atlanta
Exec. V. Pres.—Ralph F. Chambers
V. Pres.—Erwin Reveri
Sls. Mgr.—Ralph F. Chambers
Pur. Agt.—Herbert F. Loring

ILLINOIS

Able Container Co., Chicago

• **Carroll, J. B., Co.**, Chicago
Pres.—J. B. Carroll
V. Pres.—C. N. Cahill
Sales Mgr.—M. Sutherland
Pur. Agt.—L. Sloke

Felsenthal, G. & Sons, Chicago
Personnel: see p. 1077

Multiplastics, Div. of Curd Enterprises, Addison
Pres.—R. F. Curd, Jr.
Sales Mgr.—Don Lence
Pur. Agt.—Iona Brannon

• **Plastics, Laminates & Fabrics, Inc.**, Chicago
Pres. J. R. Hennessey

Plastofilm, Inc., Wheaton
Pres. & Pur. Agt.—George Wiss
V. Pres.—Vera Wiss
Sales Mgr & Secy. Treas.—Max Benaroyo

Precision Plastic Products., Inc., Chicago
Pres.—S. Z. Goldman
V. Pres.—S. L. Warshawer
Sales Mgr.—H. Paaven
Pur. Agt.—M. Vigon

•**U. S. Rubber Co. Royalite Plastic Products**, Chicago
Sales Mgr.—T. R. Grimes
Pur. Agt.—O. A. Hlavasek
Mgr. Sales Engr.—W. C. Schlager

Stanley Wessel & Co., Chicago
Pres.—Stanley Wessel
V. Pres.—William J. Higgins

INDIANA

Borkland Mfg. Co., Marion
Pres. & Owner—G. W. Borkland

• **General Plastics Corp.**, Marion
Pres.—Henry L. Erlewine
V. Pres.—Richard H. Erlewine
Sales Mgr.—Richard H. Erlewine
Pur. Agt.—C. W. Richter

Plast-Ad Mfg. Co., South Bend
President—Peter A. Gadomski
Gen. Mgr.—Peter A. Gadomski
V. Pres.—Clementine M. Gadomski
Sales Mgr. & Production Mgr.—Robert J. Gadomski
Pur. Agt.—C. M. Gadomski

IOWA

Timely Products Mfg. Co., Des Moines
Partners—Mr. E. Hadley & Bert Hadley
Sales Mgr.—Bert Hadley
Pur. Agt.—Glen Robuck

KENTUCKY

Production Aid, Inc., Middletown
Personnel: see p. 1097

LOUISIANA

Pelican Plastics, Inc., Homer
Pres.—R. G. Berryman, Jr.
V. Pres.—Dr. S. A. Tatum

MARYLAND

Artmor Plastics Corp., Cumberland
Pres., Sales Mgr., Pur. Agt.—A. C. Morgan
V. Pres.—S. Russ Minter

Falge Engineering Corp., Bethesda

Fawn Plastics Co. Inc., Baltimore
Personnel: see p. 1079

Wama Company, Baltimore
Personnel: see p. 1079

MASSACHUSETTS

Crook, William A., Co., Inc., Watertown

General Tire & Rubber Co., Belta Products Div., Lawrence
Personnel: see p. 1079

Gregstrom Corp., Cambridge
Pres.—G. A. Naylor
Sales Mgr.—Kenneth Casey
Pur. Agt.—Edwin E. Rugg

Jupiter Plastics, Inc., Pittsfield
Personnel: see p. 1097

Laminated Sheet Products Corp., Norwood
Personnel: see p. 1079

Rome Plastic Specialities, Inc., Worcester
Pres.—Harold D. Rome
V. Pres. & Treas.—Richard Rome

Transplastics Fabrication Co., Boston
Pres. M. P. Wunf

Wasco Products, Inc., Cambridge
Pres.—Max Wasserman

MICHIGAN

Acme Laminating & Plastics Co., Detroit
Pres. & Gen. Mgr.—J. D. Keiswetter
V. Pres.—Mark Berke
Sales Mgr.—Verne Sorge

Ameriplastic Company, Flint
Personnel: see p. 1079

• **Cadillac Plastic & Chemical Co.**, Detroit
Personnel: see p. 1091

Capitol Plastics Co., Inc., Lansing
Pres. & Pur. Agt.—A. E. Welke
V. Pres.—Kenneth Koppin
Sales Mgr.—C. K. Taylor

Fabri-Kal Corp., Kalamazoo
Pres. & Sls. Mgr.—R. P. Kittredge
Pur. Agt.—M. A. Klein

Imperial Industries, Inc., Wayne
Pres. & Pur. Agt.—W. G. Lewellen, Jr.
V. Pres.—Charles O. Betz
Sls. Mgr.—R. W. Struthers

Kliss Manufacturing Company, Grand Rapids
Pres. & Pur. Agt.—James C. Veen, Sr.
V. Pres. & Sls. Mgr.—James C. Veen, Jr.

Reynolds Plastics, Inc., Walled Lake
Personnel: see p. 1080

Zenith Plastics Co., Ypsilanti
Pres.—Bill Baver (owner-manager)
Sales Mgr.—G. F. Woods
Pur. Agt.—Bill Bauer

MINNESOTA

Mankato Paper Box Co., Mankato
Pres. & Gen. Mgr.—R. G. Foster
V. Pres.—N. V. Foster
Sales Mgr.—E. J. Pihale
Pur. Agt.—P. A. Mulready

Plastics, Inc., St. Paul
Pres.—H. A. Griebenow
V. Pres. & Sales Mgr.—P. K. Schilling
Secy. & Treas.—D. M. Munroe

Premier Plastic Mfg. Co., Minneapolis
Partner & Pur. Agt.—A. E. Bush
Sales Mgr.—Thomas A. Hewson, Jr.

T. O. Plastics, Minneapolis
Partners—O. R. Beech & T. W. Ingersoll
Sales Mgr.—H. J. Cummings
Pur. Agt.—J. G. Hembd

MISSOURI

Allied Plasti-Lite Enterprises, Inc., St. Louis
Pres.—Glen L. De Hart
V. Pres.—Frank H. Bottini
Secy. & Treas.—Raymond V. Vogelweid
Sales Mgr.—E. J. Brockland
Pur. Agt.—A. H. Hoff

Regal Plastic Co., Kansas City
Personnel: see p. 1081

NEBRASKA

Kerr, F. W., Plastic Co., Hastings
Personnel: see p. 1081

Kerrco Products, Lincoln
Personnel: see p. 1081

Omaha Plastics Co., Omaha
Personnel: see p. 1081

● Indicates Advertiser.

NEW JERSEY

Davis, Joseph, Plastics Co., Arlington
Personnel: see p. 1082

● **Emeloid Co. Inc.,** Hillside
Personnel: see p. 1082

Glassoloid Corp. of America, Clifton
Personnel: see p. 1092

Hunter Plastics Co., Englewood
Personnel: see p. 1098

Preservation Packaging, Inc., Hillside
Pres. & Sales Mgr.—Norton Agriss
V. Pres.—J. L. Fallick
Pur. Agt.—J. L. Fallick

● **Raritan Industries,** Paterson
Pres.—W. C. Leipold
V. Pres.—J. L. Kane
Sales Mgr. & Secy.-Treas.—M. Brown

Springfield Fabrications, Inc., Springfield
Personnel: see p. 1099

Zack Industries, Hawthorne
Pres.—Edward Zack
V. Pres.—Edward Zack
Sales Mgr.—Edward Zack
Pur. Agt.—Edward Zack

NEW YORK

American Plasticraft Co., New York
Partner—Leo Cooper
Partner—Frank Yablon

Brickmar Mfg. Corp., New York
Pres. & Sales Mgr.—Herman Julian Brickman
V. Pres.—Bert B. Brickman
Pur. Agt.—M. J. Cahn

Chelsea Mills, Div. of Novelty, New York
Gen. Mgr.—Stephen B. Freedman

Clinwill Plastics, Inc., Buffalo
Pres.—William B. Glass
Secy. & Treas.—Robert K. Glass

Durable Formed Products, Inc., New York
Personnel: see p. 1099

Emerson Plastics Corp., Bronx
Pres.—W. Elsfelder
Vice Pres.—I. Elsfelder
Sls. Mgr.—A. Margosian
Pur. Agt.—D. Singer

Emet Plastics Corp., New York
Pres.—Michel S. Schwartz
Sales Mgr.—John B. Dornan
Pur. Agt.—P. Pesso

Falk Glass & Plastic Co. Inc., Long Island City
Pres.—Leo C. Falk
V. Pres.—Frances Falk

Forbes Products Corp., Rochester
Pres.—Charles Forbes

Injection Molding Corp., New York
Pres.—Daniel D. Whyte
V. Pres. Prod.—Stanley S. Whyte
V. Pres. & Engr.—Jerome S. Stern
V. Pres. & Sls. Mgr.—Nicholas Klein
Pur. Agt.—Jay Whyte

Jodee Plastics Co., Brooklyn
Pres. & Pur. Agt.—J. D. Buglione
V. Pres.—N. Meglino
Sales Mgr.—M. Meglino
Production Engr. & Supt.—N. Meglino

Just Plastics, Inc., New York
Pres.—Charles Vermann
Sls. Mgr., Pur. Agt. & Secy. & Treas.—Martha Turi

Majestic Creations, Inc., Woodside
Pres. & Sales Mgr.—Ben J. Seger
V. Pres.—Philip Carlton
Pur. Agt.—Marvin Reichman

Marbek, Inc., Brooklyn
Personnel: see p. 1106

National Vacuum Molding Corp., Yonkers.
Pres. & Sales Mgr.—Herbert Zipkin
V. Pres.—Sam Eisenberg
Pur. Agt.—James Griffin

Paragon Plastic Corp., New York
Pres.—Allan Rosenthal
V. Pres.—S. Bardinska
Sales Mgr.—P. Bennett
Pur. Agt.—A. Dobbs

Plastic Innovations, Inc., Yonkers
Pres.—Jack Novack

Plastic Artisans, Inc., Port Chester
Pres. & Sales Mgr.—Carl W. Middleton, Jr.
V. Pres.—Earl Middleton
Pur. Agt.—George Trehubenko

Plastic Center, Rochester
Personnel: see p. 1093

Plastic Enterprises, College Point
Pres. & Pur. Agt.—Norman Zwiebel
V. Pres.—Herbert Brandon
Sales Mgr.—William Ruskin

Plasti-Vue, Whitestone

● **Plaxall, Inc.,** Long Island City
Pres.—P. M. Pfohl
Secy. Treas.—Louis H. Pfohl
Chief Engr.—Gary G. Menkel

Rosenberg Bros. & Co., Smithtown
Pres. & Sales Mgr.—Mike Rosenberg
V. Pres.—Ross Rosenberg
Pur. Agt.—Joseph Rosenberg

Shoor Form Co., Inc., Auburn
Personnel: see p. 1093

Syracuse Plastic Molders, Syracuse
Personnel: see p. 1085

Tico Plastics, Inc., New York
Pres. & Sales Mgr.—Saul Blitz
V. Pres.—I. S. Kirstein
Pur. Agt.—Charles E. Cohen

Tiger Plastics, Brooklyn
Pres.—B. Roisman
V. Pres.—Leo Newman (Production & Engr.)
Marketing and Sales—Daniel Lewis

United Mask & Novelty Co. Inc., Glendale
Personnel: see p. 1085

Whyte Mfg. Co., Inc., New York
Personnel: see p. 1085

NORTH CAROLINA

Carolina Plastics Co., Charlotte
Pres.—Don Hill
V. Pres. Sales Mgr.—D. R. Hill
Pur. Agt.—Don Hill

Complete addresses of companies listed appear on pp. 1123–1149

OHIO

Argo Plastic Products, Cleveland
Personnel: see p. 1085

•**Barron, J. E., Plastics, Inc.,** Cincinnati
Personnel: see p. 1085

Baxter Co., Cincinnati
Personnel: see p. 1100

Fabri-Form Co., Byesville
Pres.—J. W. Knight
V. Pres. & Sls. Mgr.—R. L. Baker
Pur. Agt.—E. E. Wray

Falls Hollow Staybolt Co., Cuyahoga Falls
Pres.—J. J. Walsh
V. Pres. & Sales Mgr.—E. J. Raub

Francis Industries, Pataskala
Personnel: see p. 1093

Heil Process Equipment Corp., Cleveland
Personnel: see p. 1100

•**Lincoln Molded Plastics, Inc.,** Circleville
Pres.—H. M. Jenkins
V. Pres., & Mfg. & Sales—M. W. Burkhart
Asst. Sales Mgr.—D. E. Meyers
Secy. & Treas.—James Goodman
Asst. Secy. & Treas.—E. C. Jankura

Plastic Parts Corp., Maumee
Personnel: see p. 1100

Plastic Products Corp., Bedford Heights
Pres. & Treas.—S. B. Knight
V. Pres. & Secy.—Earl P. Schneider
Sales Mgr.—Arthur B. Robinson
Pur. Agt.—Charles B. Clark, Jr.

•**Vacuum Plastics Corp.,** Columbus
Pres.—Herbert S. Cook
V. Pres.—Preston Davis
Secy.—James Gorrell
Pur. Agt.—Martin L. Grosh

Vichek Tool Co., Cleveland
Pres. & Treas.—E. C. Koster
V. Pres.—L. F. Storie (Secy.)
Sales Mgr.—R. E. Imhoff
Pur. Agt.—F. J. Tkach
Mgr., Plastic Div.—D. R. Butler

•**Yardley Plastics Co.,** Columbus
Personnel: see p.

OKLAHOMA

Plastic Engineering Co., Tulsa
Owner—Daniel M. Byrne
Sales Mgr.—K. J. Fitzgerald

Tulsa Plastics, Tulsa
Pres., Sls. Mgr., Pur. Agt.—W. D. Howell
V. Pres.—Betty Howell

PENNSYLVANIA

Atlas Mineral Products Company, Mertztown
Pres.—Joseph A. Snook
V. Pres.—George P. Gabriel
V. P. & Sales—Eugene Kirkpatrick
Pur. Agt.—John J. Gonzalez

Bruce Molded Plastic Products, Pittsburgh
Pres.—L. F. Marks
V. Pres.—Leonard Louik

•**Consolidated Molded Products Corp.,** Scranton
Pres.—J. O'Connell
V. Pres. & Supt.—E. W. Birney
V. Pres. & Sales Mgr.—J. W. Pillinger

Delaware Valley Plastics Co., Philadelphia
Sales & Design: Partnership

McClarin Plastics, New Oxford
Personnel: see p. 1101

•**Port Erie Plastics Corp.,** Erie
Pres.—H. J. Witkowski

Reinhardt, J. A., & Co., Mountainhome
Pres.—John A. Reinhardt, Jr.
V. Pres.—John A. Reinhardt, Sr.
Sales Mgr. & Pur. Agt.—Robert Reinhardt

Sealview Plastics, Inc., Wayne
Personnel: see p. 1101

Strick Plastics, Perkasie
Personnel: see p. 1093

RHODE ISLAND

Anchorage Plastics, Inc., Warren
Personnel: see p. 1088

•**Tupper Corp.,** Woonsocket
Pres.—Earl S. Tupper

TENNESSEE

Snapvent Company, Knoxville
Mgr.—Burton B. Simcox

TEXAS

Lone Star Plastics Co., Inc., Fort Worth
Personnel: see p. 1102

Plastics Center of Texas, San Antonio

Wyatt's Plastics, Inc. Houston
Personnel: see p. 1089

VERMONT

Manchester Molding Co., Manchester
Pres.—R. L. Thomson
Sales Mgr.—H. J. Stratton
Pur. Agt.—C. R. Ellingwood

Newport Plastics Corporation, Newport
Personnel: see p. 1089

VIRGINIA

Lurie Plastics, Inc., Colonial Heights
Pres.—R. Lurie
Plant Mgr.—G. Finney
Coordinator—J. Coleman
Pur. Agt. & Chief Engr.—H. J. Schroeder

O'Sullivan Rubber Corp., Winchester
Personnel: see p. 1107

WASHINGTON

A & B Plastics, Seattle
Personnel: see p. 1102

Durable Plastics Co. Inc., Seattle
Pres.—Henry H. Gray
V. Pres.—Thelma E. Gray
Sales Mgr.—H. H. Gray
Pur. Agt.—W. K. Newcomb

General Plastics Mfg. Co., Tacoma
Pres., V. Pres., Sales Mgr. & Pur. Agt.—L. W. Schatz.

Pacific Plastics Co., Inc., Seattle
Personnel: see p. 1089

WISCONSIN

Evans-Zeier Plastic Co., Madison
1-very large vacuum machine
Partners—D. L. Evans & R. V. Zeir

Portz-Plastics & Fibre Co., Milwaukee
Pres. & Pur. Agt.—Charles A. Portz
V. Pres.—Charles Anthony
Sales Mgr.—R. Chop

Premier Plastics Co., Milwaukee
Pres.—Robert W. Ray
V. Pres.—William R. Ross
Pur. Agt.—Miss Merry Blatnik

Trim Molded Products Co., Inc., Burlington
Pres. & Treas.—Russell F. Hagen
V. Pres.—Louis J. Robbers
Sales Mgr.—William Leslie
Secy. & Pur. Agt.—Jack Samuels

CANADA

Hathaway Kraemer, Ltd., Kitchener, Ont.
Pres.—A. G. Hathaway
V. Pres. & Pur. Agt.—James E. Kraemer

ENGLAND

•**Microcell, Ltd.** London
Personnel: see p. 1094

•Indicates Advertiser.

VINYL FILM, SHEETING, AND COATED FABRIC MANUFACTURERS*

A—Calendered Vinyl Film; *B*—Cast Vinyl Film; *C*—Calendered Vinyl Sheeting; *D*—Vinyl Coated Fabric

CALIFORNIA

Elley Rubber Co., Los Angeles (*A, C*)
Pres.—D. C. Maine
V. Pres. & Treas.—E. P. Schreiner
Sales Mgr.—C. E. Watts
Pur. Agt. & Secy.—R. E. Reid

Flexfirm Products, El Monte (*D*)
Gen. Mgr.—Dudley Eichorn
Sales Mgr.—Al Michels
Pur. Agt. & Office Mgr.—James J. Goggin

Navarm Chemical Co., Maywood (*A, C*)
Pres.—Willard Abner
Sales Mgr.—Thomas E. Palmer
Pur. Agt.—P. A. Ainsworth

CONNECTICUT

●**Cordo Chemical Corp.,** Norwalk (*C, D*)

●**Naugatuck Chemical,** Naugatuck (*A*)

Plastic Film Corp., Plainfield (*B, D*)
Pres. & Treas.—W. B. Nichols
Exec. V. Pres. & Gen. Mgr.—A. C. Bruce
V. Pres.—E. V. Disch
Sales Mgr. Industrial—T. A. Lancaster
Sales Mgr. Consumer Goods—R. Arsenault
Pur. Agt. Controller—G. E. Hagert

Ross and Roberts Co., Stratford (*A, C*)
Pres.—Arthur M. Ross, Jr.
V. Pres. & Sales Mgr.—Alvin V. Roberts

●**U. S. Rubber Company, Naugatuck Chemical Division,** Naugatuck (*A*)
Pres.—H. E. Humphreys, Jr.
V. Pres.—J. E. Caskey
Sales Mgr.—E. S. Ebers
Pur. Agt.—R. S. Tobias

ILLINOIS

Joanna Western Mills Co., Chicago (*D*)
Pres.—W. F. Regnery
V. Pres.—F. L. Regnery
Sales Mgr., Industrial Fabrics Division—E. J. Fraunfelder
Sales Mgr., Plastic Fabrics Div.—J. P. Haughton

MASSACHUSETTS

●**General Tire & Rubber Company, Bolta Products Division,** Lawrence (*A, C, D*)
Gen. Mgr.—John Bolton, Sr.
Asst. To The Gen. Mgr.—Frederick Dodkin
Gen. Sales Mgr.—Sumner L. Trilling
Pur. Agt.—Wayne Grubaugh

Goodall-Sanford, Inc., Reading (*D*)
Pres.—Walter E. Greer
V. Pres.—George E. Norman, Jr.
Sales Mgr.—Robert F. Daughters
Pur. Agt.—William E. Rock

Leathertone, Inc., Boston (*D*)
Pres., Pur. Agt. & Plant Mgr.—Jules Rubenstein
V. Pres. & Designer—Iris Dale
Sales Mgr.—Louis Rubenstein

●**Sandman, Eli, Co.,** Worcester (*D*)
Pres.—Eli Sandman
Pur. Agt.—E. A. McDonald

NEW JERSEY

L. E. Carpenter & Co., Wharton (*D*)
Personnel: see p. 1098

●**Joseph Davis Plastics Co.,** Arlington (*A, C*)
Pres.—Morton Davis
V. Pres.—Abraham Davis
Sales Mgr.—Lincoln Steinhardt
Pur. Agt.—Sam Goldblatt

Electro-Technical Products, Nutley (*D*)

●**Polyplastex United, Inc.,** Union (*D*)
Pres.—H. W. E. Riley
Sales Mgr.—R. W. D. Heins
Pur. Agt.—Maurice Furie

Spiral Glas Pipe Co., New Brunswick (*A, C*)
Pres.—Carl de Ganahl
Sales Mgr.—C. Brice de Ganahl
Pur. Agt.—Amy MacKenzie

NEW YORK

American Combining Corp., Rockaway Beach, N. Y. (*D*)
Pres. & Sales Mgr.—J. T. Rudman
V. Pres. & Pur. Agt.—M. Kant

Anorgano G. M. G. H., New York (*A, B, C*)

Associated Rubber & Plastic Corp., New York (*C, D*)
Pres.—Hyman Robbins
V. Pres. & Sales Mgr.—Ben Robbins
Pur. Agt.—Bernard Greenwald

Blossom Mfg. Co., New York (*A, C, D*)
Pres.—Dave Schoenfeld
V. Pres.—Samuel J. Brandstein
Sales Mgr.—Morton Margolies
Pur. Agt.—Jack Antokal
Gen. Mgr.—Bill Glazer

Elm Coated Fabrics Co. Inc., New York (*A, C, D*)
Pres.—A. Mittman
V. Pres.—E. Mittman
Sales Mgr.—M. H. Grant
Pur. Agt.—E. Siskind

Gordon-Lacy Chemical Products Co., Inc., Maspeth (*A, C, D*)
Pres.—Robert Lacey
V. Pres.—Robert Gordon
Sales Mgr.—Gerard Rothbart
Pur. Agt.—Herman Lacey

Harte & Co., Inc., New York (*A, C, D*)
Personnel: see p. 1062

Marbek, Inc., Brooklyn (*D*)
Pres.—Joseph S. Kaye
V. Pres., Sales Mgr. & Pur. Agt.—Seymour Griss

●**Muehlstein, H. & Co., Inc.,** New York (*A, B, C, D*)
Pres.—Herman Muehlstein
V. Pres.—A. Chester
Sls. Mgr.—H. Heller—Vinyl

Pantasote Company, New York (*A, C, D*)
Pres.—Hans Wyman
V. Presidents—Charles A. Wyman, Henry W. Wyman, S. D. Maloney, John D. Foley
Sales Mgr.—S. D. Maloney
Pur. Agt.—E. D. Randall, J. F. Gutschalk

Protective Lining Corp., Brooklyn (*A, C*)
Pres.—Jerome J. Dorfman

●**Rubber Corp. of America,** Hicksville (*A, C*)
Pres.—W. A. Merton
V. Pres.—R. G. Merton
Sales Mgr.—A. W. Merton
Pur. Agt.—Dinah Martin

Rudd Plastic Fabrics Corp., Brooklyn (*A, C, D*)
Pres.—Michael Bex
Sales Mgr.—Jerry Phillips
Pur. Agt.—Albert Novet

Sommers Plastic Products Co., New York (*C*)
Pres.—Herman Schecter
Sales Mgr.—Irving Rifkin
Pur. Agt.—Matty Matlin

OHIO

●**Barron, J. E., Plastics, Inc.,** Cincinnati (*A, B, C*)
Personnel: see p. 1085

●**General Tire & Rubber Co.,** Akron (*A, C*)
Pres.—William O'Neil
V. Pres.—L. A. McQueen
Pur. Agt.—D. A. Kepler

●**Seiberling Rubber Company, Plastics Div.,** Newcomerstown (*A, C*)
Pres.—J. P. Seiberling

*Note: FILM is thickness of 10 mils or less. SHEETING is unsupported sheet in thickness of over 10 mils.

●Indicates Advertiser.

Complete addresses of companies listed appear on pp. 1123-1149

V. Pres.—H. P. Schrank
Sales Mgr.—C. J. Figenscher (Plastic Div.)
Gen. Mgr.—Harry M. Zimmerman
Pur. Agt.—W. H. Oran

●**Textileather, Div., The General Tire & Rubber Co.,** Toledo (*C, D*)
Gen. Mgr.—S. P. Lippmann
Director of Sales—G. H. McGreevy
Sales Mgr.—J. S. Mather
Pur. Agt.—Carl Fuller

PENNSYLVANIA

●**Firestone Plastics Co.,** Pottstown (*A, C*)
Pres.—Roger S. Firestone
Exec. V. Pres.—E. T. Handley
V. P. & Velon Products—K. L. Edgar
Pur. Agt.—Thomas Storm

●**Scranton Plastic Laminating Corp.,** Scranton (*A, C*)
Pres.—D. P. Keisling
Sales Mgr.—L. F. Hardy
Pur. Agt.—C. W. Walter

●Indicates Advertiser.

RHODE ISLAND

●**Respro Div., The General Tire & Rubber Co.,** Cranston (*A, C, D*)
Gen. Mgr.—L. D. Bragg, Jr.
Gen. Sales Mgr.—John E. Manion
Pur. Agt.—John M. O'Grady
Sales & Adv. Mgr., Plastic Products—W. H. Young, Jr.

VIRGINIA

Electro Plastic Fabrics, Pulaski (*D*)
Pres.—Richard Beaver
V. Pres.—James Lower
Sales Mgr.—Singleton & Mack, Inc.
Pur. Agt.—Mr. Mashuff, Jr.

O'Sullivan Rubber Corp., Winchester (*C*)
Exec. V. Pres.—Paul Terretta
Sales Mgr.—C. R. Creamer, Jr.
Pur. Agt.—William O. Grove

Reynolds Metals Co., Plastics Div., Grottoes (*B*)
Gen. Mgr.—W. J. Vogel
Asst. Market Mgr.—R. L. Moore

CANADA

Canadian Geneva-Tower Ltd., Galt, Ontario (*A, C, D*)
Pres.—Gordon Chaplin
Sales Mgr.—F. W. Graham
Pur. Agt.—E. Willis

Canadian Resins & Chemicals Ltd., Montreal, Que. (*A, C, D*)
Pres.—R. J. Southwell
V. Pres. Sales—Mr. G. M. Hale
V. Pres. Manufacturing—J. C. Hamilton
Pur. Agt.—J. R. Hazle

ENGLAND

BX Plastics Ltd., London (*A, C*)

JAPAN

●**Monsanto Kasei Chemical Co.,** Tokyo (*A, B, D*)
Pres.—Shikao Satow
V. Pres.—J. R. Turnbull
Sales Mgr.—H. Shirimizu
Pur. Agt.—R. Sakakura

NOTICE

Despite every effort of the editors to make this Directory Section as complete and authoritative as possible, some companies which should be listed have, we feel sure, been overlooked. In January, 1958, preparation of the Directory Section for the 1957 Modern Plastics Encyclopedia Issue will get under way, and if you want your company to be included, the time to do something about it is *right now*.

Listings in the Directory Section are restricted to manufacturers of plastics chemicals and materials, to machinery and equipment manufacturers, and to businesses performing *custom* services—such as moldmakers, molders, laminators, fabricators, film processors, and the like.

If your company was listed this year, you will automatically receive a listing sheet for the 1958 Directory Section. If your company falls into one of the categories mentioned above and was *not* listed this year, write today and ask that a listing sheet be sent you. Please remember that we will not mail 1958 listing sheets before January 15, 1958.

Directory Editor

MODERN PLASTICS ENCYCLOPEDIA ISSUE

575 Madison Avenue New York 22, N. Y.

Complete addresses of companies listed appear on pp. 1123-1149

DIRECTORY OF TRADE DESIGNATIONS OF PLASTIC MATERIALS AND PROCESSES

This list of trade designations is compiled for reference purposes from information supplied to us by the companies concerned. The descriptive information, however, is not guaranteed although, with a few exceptions, each of the trade designations was accompanied by a registration number and date. For complete addresses, refer to alphabetical list, page 1123.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
	A	
A-C Polyethylene	Low-molecular-weight polyethylene	Semet-Solvey Petrochemical Division, Allied Chemical and Dye Corp., N.Y., N.Y.
A-M	Adhesives, resins, chemicals, etc.	American-Marietta Co., Adhesive, resin & Chemical Division, Seattle, Washington
Acco	Polymers, copolymers of acrylic & methacrylate esthers. Specialty-private formulas	Acco Polymers, New York, New York
AccuRay	Industrial beta gauges used in measuring the weight, thickness, and area of sheet materials.	Industrial Nucleonics Corp., Columbus, Ohio
Ace Rijt-Tuf	Resinous copolymer for molded products	American Hard Rubber Co., N.Y., N.Y.
Ace Rivicler	Unplasticized polyvinyl chloride	American Hard Rubber Co., N.Y., N.Y.
Ace Tempron	Heat resistant rubber plastic blend	American Hard Rubber Co., N.Y., N.Y.
Ace-Flex	Thermoplastic tubing and sheet	American Hard Rubber Co., N.Y., N.Y.
Ace-Hide	Rubber-plastic blend molding compound	American Hard Rubber Co., N.Y., N.Y.
Ace-lite	Multi-polymer rubber and plastic molding compound	American Hard Rubber Co., N.Y., N.Y.
Ace-Tex	Black bituminous molding compound	American Hard Rubber Co., N.Y., N.Y.
Acetamine	Dyes	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Delaware
Acro-Bevel	Mold Marking Stamps	Acromark Company, Elizabeth, New Jersey
Acro-Cast	Cast Metal Molds	Acromark Co., Elizabeth, N.J.
Acro-Ink	Plastic and Metal Marking Inks	Acromark Company, Elizabeth, N.J.
Acrobess	Hot Stamping (also) Metal Embossing	Acromark Co., Elizabeth, N.J.
Acrocut	Letter Cutting In Molds or Dies	Acromark Co., Elizabeth, N.J.
Acrodie	Precision Dies	Acromark Co., Elizabeth, N.J.
Acrograve	Metal and Plastic Engraving	Acromark Company, Elizabeth, N.J.
Acrohex	Electric Branders for Plastic, Wood, Fibre.	Acromark Company, Elizabeth, N.J.
Acromark	Marking & Numbering Machines	Acromark Co., Elizabeth, N.J.
Acromarker	Name Plate Stamping Machines	Acromark Co., Elizabeth, N.J.
Acronal	Polymers of acrylic esters and mixed polymers in the form of acqueous dispersions and solutions.	Badische Anilin- & Soda Fabrik A. G., Germany
Acroprene	Synthetic Rubber Dies	Acromark Company, Elizabeth, N.J.
Acroprinter	Parts Printing Machines	Acromark Co., Elizabeth, N.J.
Acrostamp	Stamps for Marking Plastic, etc.	Acromark Co., Elizabeth, N.J.
Acrotool	Marking & Engraving Tool	Acromark Co., Elizabeth, N.J.
Acrotype	Precision Stamping Type	Acromark Co., Elizabeth, N.J.
Acrylon	Rubber	Borden Company, Chem. Div., New York, N.Y.
Ad-Ons	Vacuum formed designs to be applied to larger plastic items.	W. L. Stensgaard and Associates, Inc., Chicago, Ill.
Adipol	Plasticizers-adipate esters.	Ohio-Apex Div. F.M.C., Nitro, W. Va.
Advastab	Heat and Light Stabilizers for Chlorinated Resins.	Advance Solvents and Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, New Jersey
Advawet	Additive-Viscosity Depressent	Advance Solvents and Chemical, Div. of Carlisle Chemical Works, Inc., New Brunswick, New Jersey
Aer-O-Buoy	Polyvinyl chloride foams	Robinson Moulded Products, Ltd., Toronto, Ontario, Canada
Aeroflex	Polyethylene Extrusions	Anchor Plastics Co., Long Island City, N.Y.
Agilene	Polyethylene semi-finished components (sheet, rod, tube, bar, etc.)	American Agile Corp., Maple Heights, Ohio
Agilide	Non-plasticized polyvinyl chloride semi-finished components	American Agile Corp., Maple Heights, Ohio
Air-Clamp	Air Cylinders	Mead Specialties Co., Inc., Chicago, Illinois
Aircomb	Impregnated Kraft Honeycomb	Douglas Aircraft Co., Inc., Santa Monica, Calif.
Airmatic	Air valves, air cylinders, hydraulic valves and hydraulic cylinders	Airmatic Valve, Inc., Cleveland, Ohio
Aldorome	Odorants for Formaldehyde	Fritzsche Brothers, Inc., New York, New York
Alfane	Epoxy based cement	The Atlas Mineral Products Co., Mertztown, Penna.
Alkonex	Polyester coating materials	General Electric Co., Chemical Materials Dept., Pittsfield, Massachusetts
Alker	Furan resin cement	The Atlas Mineral Products Co., Mertztown, Penna.
Alipal	Surface active agent; antistatic agent	Antara Chemicals, Division of Aniline & Film Corp., New York, New York
Alk-O-Flex	Plasticizers, low temperature laminating resins, heat and light stabilizers	Alkydol Laboratories, Inc., Cicero 50, Illinois
Alk-O-Mer	High polymer emulsions	Alkydol Laboratories, Inc., Cicero 50, Illinois
Alpex	Hydrocarbon resins	Alkydol Laboratories, Inc., Cicero, Illinois
Alundum	Abrasives, Grinding Wheels, Refractories	Norton Co., Worcester, Mass.
Airborne	Expanded Plastic (urethane foam)	Albert Trostel & Sons Co., Airborne Division, Milw., Wis.
Airoyal	Air cylinders, hydraulic cylinders, hydraulic power units	The Airoyal Co., Maplewood, New Jersey
Akroflex	Rubber Antioxidants	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Delaware
Alathon	Polyethylene resin, molding compounds	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Del.
Alchemick	Alkyd Enamel Interior or Exterior	Triacon Laboratories Division, Devoe and Raynolds Co., Inc., Detroit, Michigan
Alkanol	Surface Active Agents	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Delaware
Alperox C	Organic Peroxide type Catalysts	Lucidol Div., Wallace & Tiernan, Inc., Buffalo, N.Y.
Amco Plastic Pipe	Plastic pipe	Amco Plastic Pipe Co., San Leandro, California
Ameron	Liquid Dispersions of Plastic Materials	B. F. Goodrich Co., Akron, Ohio
Amercoat	Protective coatings	Amercoat Corp., South Gate, Calif.
Amester	Polyester resins	American Alkyd Industries, Carlstadt, New Jersey
Ampacet	Thermoplastic Molding Compounds	American Molding Powder & Chemical Corp., Brooklyn, N.Y.
Amphosive	Series of adhesives for industrial use.	Atlas Mineral Products Co., Mertztown, Penna.
Ampreg	Polyester resin coating	The Atlas Mineral Products Co., Mertztown, Penna.
Amres	Phenolic, Resorcinol, Urea Resins	American-Marietta Co., Adhesive, Resin & Chem. Div., Seattle, Washington
Analyte	Color comparator	Crown Engineering and Sales Co., Harrison, N.J.
Anesite	Thermoplastic Pipe Tubing, and other Cross-Sections	Anesite Co., Chicago, Illinois

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Anesite	Extruded thermoplastic products	Anesite Co., Chicago, Illinois
Ansol	Denture alcohol solvent	U.S. Industrial Chemicals Co., Div. National Distillers and Chemical Corporation, New York, New York
Anstol C	Anti-Static Agents	Chemical Development Corp., Danvers, Mass.
Antamx	Surface active agent; dispersant in cellophane mfg.	Antara Chem., Sales Div. of Gen. Aniline & Film Corp., New York, N.Y.
Antox	Rubber Antioxidants	E. I. du Pont de Nemours & Co., Inc., Polychemical Dept., Wilmington, Delaware
Aquablak	Carbon Black dispersed in water	Columbian Carbon Co., New York, N.Y.
Aquarex	Mold lubricant	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Del.
Aquarex	Surface Active Agent	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Delaware
Aquatel	Moisture gauge	Isotope Products, Buffalo, New York
Arabol	Adhesives	The Arabol Mfg. Co., New York, New York
Archer	Self-adhesive Labels and Label Dispensers	Archer Label Company, Los Angeles, California
Arcturus	Colorants (red)	The Sherwin-Williams Co., New York, New York
Ariteno	Epoxy resin formulations	Aries Laboratories, Inc., New York, N.Y.
Armorhide	Textured plastic finish resembling leather for use on metal, plastics, etc.	John L. Armitage & Co., Newark, N.J.
Armor	Vinyl and polyethylene film and sheeting	Ross & Roberts Co., Stratford, Conn.
Astralon	Vinyl chloride polymer	Dynamit-Actein-Gesellschaft Troisdorf, W. Germany
Atlac	Solid Polyester Resin	Atlas Powder Co., Wilmington, Delaware
Atlastasol	Vinyl plastisol	Atlas Mineral Products Co., Mertztown, Pennsylvania
Ase	Antiskinning agent	National Aniline Division, Allied Chemical & Dye Corporation, New York, 6, N.Y.
Asp	Mineral Filler	Minerals & Chemicals Corp. of America, Menlo Park, New Jersey
Auto-Tap	Lead screw tapping heads and attachments and automatic tapping machines	Automatic Methods, Inc., Elizabeth, New Jersey
Aviaco	Urea-formaldehyde molding compounds	American Viscose Corporation Philadelphia, Pennsylvania
Avitex	Surface Active Agents, Softeners, Antistatic Developer.	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept. Wilmington, Delaware
Bakelite	Phenolic, polystyrene, polyethylene, Fluorothene, vinyl chloride, vinyl acetate, vinyl butyral, polyester, and epoxy resins; molding materials; extrusion compounds; sheeting and film; rigid sheets; laminating varnishes for high-, low-, and contact-pressure laminated plastics; laminating compounds; synthetic resins for paints and varnishes; resins for baking and surface coatings; resins for impregnating, calendering, and bonding; resin wood glues; technical cements; and resins for adhesives.	Bakelite Co., a Div. of Union Carbide & Carbon Corp. New York, N.Y.
Banbury	Mixers	Farrel-Birmingham Co., Inc. Ansonia, Conn.
Bandsander	Belt sander	Mead Specialties Co., Chicago, Ill.
Barak	Accelerator Activator	E. I. du Pont de Nemours Co., Inc., Poly chemical Div., Wilmington, Del.
Barco	Stabilizers	Deecy Products Co., Cambridge, Mass.
Barco	Joints: flexible, swivel, swing and revolving	Barco Manufacturing Co., Barrington, Illinois
Bar-Ox	Aklyd Steel Paint	Truscon Labs., Div. of Devoe & Reynolds Co., Inc. Detroit, Michigan
Beckamine	Alcohol soluble urea, Formaldehyde resins	Reichhold Chem., Inc., White Plains, New York
Beckerley	Precision Weights	The Torsion Balance Company Clifton, New Jersey
Beckolin	Synthetic oils	Reichold Chem., Inc., White Plains, New York
Beckopol	High melt point modified phenolic resins	Reichhold Chem., Inc., White Plains, N.Y.
Beckosol	Alkyd resins	Reichhold Chem., Inc., White Plains, N.Y.
Balcabalsa	Core Material for RP	Balsa Ecuador Lumber Corp., New York 36, N.Y.
Beetle	Urea-formaldehyde molding material	American Cyanamid Co., Plastics and Resins Div., New York, N.Y.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Benvic	Vinyl Chloride and Vinyl acetate chloride compounds.	S. A. Solvic, Brussells, Belgium
Betacoater	Beta gauge for coaters	Isotope Products, Buffalo, New York
Betameter	Beta gauge	Isotope Products, Buffalo, N.Y.
Bi-Line	Two flexible Polyethylene Pipes continuously joined for Jet Well installations.	Skyline Industries, Skyline Plastic Pipe, Inc., Skyline Plastic Molding, Inc., Titusville, Pennsylvania
Binac	Time-cycle controller	Taylor Instrument Companies, Rochester, New York
Bipel	Presses Compression,-Hydraulic Pelleging Machines,-Power units-hydraulic,-Hydropneumatic Accumulators-Presses-transfer molding,-Controllers - temperature, - Press Platens-electric-induction heated.	B. I. P. Engineering Limited, Sutton Coldfield, Warwickshire, England
Bi-Therm	Bi-Metalic industrial thermometers	Taylor Instrument Companies, Rochester, New York
Black-Buty	Plastic pipe and pipe fittings	Anesite, Company, Chicago, Illinois
Black Pearls	Pelleted channel carbon blacks	Godfrey L. Cabot, Inc., Boston, Mass.
Black-Poly	Polyethylene Pipe & Tubing	Anesite Co., Chicago, Illinois
Blend-oxo	Wetting Agent	Gering Products, Inc., Kenilworth, New Jersey
Boltaflex	Supported & unsupported flexible vinyl sheeting	Bolta Co., Inc., Lawrence, Mass.
Bolta-Quilt	Quilted plastic films	Bolta Co., Inc., Lawrence, Mass.
Baltaron	High-impact, low-pressure moldable plastic (a copolymer)	Balta Co., Inc., Lawrence, Mass.
Bonar	Cellulosic boning (extruded)	Anchor Plastics Co., Inc., Long Island City 6, N.Y.
Bonate	Structural Articles made with reinforced resins	Carl N. Bettle Plastics Corp., Fall River, Massachusetts
Bonding Agent	Metal to Metal Adhesive, Epoxy metal adhesive	Carl H. Biggs Co., Inc., Los Angeles, Calif.
Bondmaster	Industrial adhesives for plastics and metals	Rubber and Asbestos Corporation, Bloomfield, New Jersey
Bontex	Shade cloth, plastic coated	Columbus Coated Fabrics Corp., Columbus 16, Ohio
Bostilm	Vinyl plastic in sheet form, coated with adhesive	B. B. Chemical Co., Cambridge Massachusetts
Bostape	Adhesive coated reinforcing tape	B. B. Chemical Co., Cambridge, Massachusetts
Bostik	Adhesive	B. B. Chemical Co., Cambridge, Massachusetts
Brighton Leaf	Roll leaf	Griffin, Campbell, Hayes, Walsh, Inc., New York, New York
Broncho	Composition supported vinyl	Textileather Div., The Gen. Tire & Rubber Co., Toledo, Ohio
Brushmaster	Paintbrush setting compounds	Rubber & Asbestos Corp., Bloomfield, New Jersey
Butacite	Polyvinyl butyral sheeting	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington 98, Del.
Butvar	Polyvinyl butyral resins	Shawinigan Resins Corp., Springfield, Mass.
	C	
C.D.	Products made by Chemical Dev. Corp. Lubricants, Adhesives, Coatings, etc.	Chemical Development Corp., Danvers, Mass.
Cabflex (line)	Plasticizers	Godfrey L. Cabot, Inc., Boston, 10, Mass.
Cab-O-Sil	Colloidal Silica-Thickening, Thixotropic, Suspension, Dispersing Agent	Godfrey L. Cabot, Inc., Boston, Massachusetts
Cadco	Cast acrylic rods and tubes-cements, polishes, adhesives-acrylic general purpose; fast setting; monomer and monomer polymer cements and adhesives-bodied adhesives for acetates, styrenes, vinyls-formed plastics & bodies adhesives & solvent adhesives for vinyls to vinyls & vinyls to dissimilar materials, also bodies adhesives for nylon and phenolics. Anti-static polishes for acrylics, vinyls, etc.	Cadillac Plastic Co., Detroit, Michigan
Cadox	Organic Peroxide Catalysts	Cadet Chemical Corp., Burt, N. Y.
Calcerite	Amino-resin casting compound	Furance Plastics, Inc., Los Angeles, California
Calvinac	Vinyl based air dry coatings in colors	James Lithgow Co., Inc., Torrance, Calif.
Calvoseal	Masonry sealant	Lithgow Chemicals Co., Div. of Reinhold Engineering & Plastics Co., Norwalk, California
Calwhite	Natural calcium carbonate extender water ground from White Georgia Crystalline Marble.	The Calcium Products Division, The Georgia Marble Co., Tate, Georgia

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Campco	Thermoplastic sheet and film	Campco Div., of Chicago Molded Products Corp., Chicago, Ill.
Caprocyl	Dyes	E. I. du Pont de Nemours Co., Inc., polychemical div.—Wilmington, Del.
Carbasol	Modified Rosin Esters	C. J. Osborn Co., Linden, New Jersey
Carbolac	High Color, channel carbon blacks	Godfrey L. Cabot, Inc., Boston, Mass.
Carbowax	Polyethylene glycols	Carbide and Carbon Chemicals Co., New York, N.Y.
"Carver Press"	Hydraulic Laboratory Press	Fred S. Carver, Inc., Summit, New Jersey
Cascomite	Powdered synthetic resin adhesives	The Borden Co., Chemical Div., New York, New York
Casco	Glues and adhesives	The Borden Co., Chemical Div., New York, New York
Cascola	Label glue	The Borden Co., Chemical Div., New York, New York
Cascolac	Aqueous casein coating solutions	The Borden Co., Chemical Division, New York, New York
Cascophen	Glues	The Borden Co., Chemical Div., New York, New York
Cascorez	Resin glue	Borden Co., Chemical Div., New York, New York
Cascote	Synthetic resin	The Borden Co., Chemical Div., New York, New York
Castaloy	Clamps, laboratory	Fisher Scientific Co., Pittsburgh, Pennsylvania
Celanese	Acetate film, sheeting, molding material, polyethylene film, sheeting, rigid sheeting, polyester resins, polyvinyl acetate emulsions.	Celanese Corp. of America, Newark, New Jersey
Celanthrene	Dyes	E. I. du Pont de Nemours Co., Inc., Polychemical div., Wilmington, Delaware
Celite	Diatomite products-filter aids and mineral fillers	Johns-Manville, New York, N.Y.
Cellon	Cellulose Acetate with Plasticizers.	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Cellosize	Hydroxyethyl cellulose	Carbide & Carbon Chemicals Co., New York, N.Y.
Celogen	Nitrogen blowing agent for plastics and rubber.	Naugatuck Chemical Division, U.S. Rubber Co., Naugatuck, Connecticut
Celoron	Electrical insulating material	Continental-Diamond Fibre Division of The Budd Co., Inc., Newark, Del.
Cenco McLeod Gages	High Vacuum Gages	Central Scientific Co., Chicago, Ill.
Century Brand	Fatty acids	Harchem Division, Wallace & Tiernan Inc., Belleville, New Jersey
Ceramicon	Capacitors	Erie Resistor Corp., Erie, Pennsylvania
Cerama	Thermocouple wire	Thermo Electric Co., Inc., Saddle Brook, New Jersey
Certus	Vinyl resins	Monite Waterproof Glue Co., Minneapolis, Minn.
Chainomatic	Analytical Balances	The Torsion Balance Co., Clifton, New Jersey
Chemelec	Teflon with additives to alter properties for special applications in process industry and electronic field	United States Gasket Co., Camden, New Jersey
Chemiseal	Teflon gaskets—packing special fabricated items generally required by chemical & process industry	United States Gasket Co., Camden, N.J.
Chemigum	Butadiene/acrylonitrile rubbers	The Goodyear Tire & Rubber Co., Akron 16, Ohio
Chemigum Latices	Butadiene/acrylonitrile copolymer latices	The Goodyear Tire & Rubber Co., Akron, Ohio
Chemlon	Fabricated teflon products	Crane Packing Co., Morton Grove, Ill.
Chem-o-glas	Glass fiber reinforced building panels	Chemold Co., Santa Monica, California
Chem-o-sol	Dispersions of high molecular weight, vinyl chloride polymer, or copolymer, resins in liquid plasticizers—compounds for molding, spreader coating, die wiping, extrusions, dipping, and spraying.	Chemical Products Corp., East Providence, Rhode Island
Chemrok	Chemical resistant plastics for electroplating apparatus & parts thereof, as for other chemical resistant parts	The Richardson Co., Melrose Park, Illinois
Chiksan	Ball-bearing swivel Joints and rotating Joints	Chiksan Co., Brea, Calif.
The Chilton Process	For: Mechanically inlaying articles of manufacture with designs and figures made of metal	Plastic Inlays, Inc., Summit, New Jersey
Chlorowax	Chlorinated Paraffin Wax	Diamond Alkali Co., Cleveland, Ohio
Christian Becker	Analytical Balances	The Torsion Balance Company, Clifton, New Jersey
Chromacyl	Dyes	E. I. du Pont de Nemours Co., Inc., Polychemical Div., Wilmington, Delaware
Chromcote	Chrome colored vacuum metallized finish.	The Eyelet Specialty Co., Waterbury Conn.
Chromolox	Electric Heating Equipment	Edwin L. Wiegand Co., Pittsburgh, Pennsylvania
Cincinnatus	Heavy duty double arm mixers	J. H. Day Co., Cincinnati, Ohio
Clapco	Radiant heaters, immersion heaters	Cleveland Process Co., Cleveland, Ohio
Clopane	Clear vinyl packaging film, heat sealable and printable	Clopay Corp., Cinn., Ohio
Co Ros Co	Corrosion resistant coatings	Cordo Chemical Corp., Norwalk, Conn.
Coblak	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Coathiokblak	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Collacral	Thixothropic agent for dispersions and for the production of specialty adhesives.	Badische Anilin- & Soda Fabrik A. G., Germany
Colorite Buttons	Dyeing of plastic parts and/or buttons	Colorite Buttons, New York, New York
Col-o-Vin	Vinyl coated fabric & vinyl unsupported sheeting	Columbus Coated Fabrics Corporation, Columbus, Ohio
Colton	Complete line of machines	Arthur Colton Co., Detroit, Michigan
Computreater	Single end tire cord laboratory unit	C. A. Litzler Co., Inc., Cleveland, Ohio
Conductex	Conductive compounds (electrical)	H. V. Hardman Co., Inc., Belleville, New Jersey
Conoco	Secondary plasticizer for PVC Resin Formulations	Continental Oil Co., Petrochemical Dept., New York, New York
Conolite	Conolite laminates are all based on polyester resins and are provided in both decorative and industrial types. Decorative types are utilized mainly as surface coverings in the traditional manner and are particularly adaptable to the "Do-it-yourself" trade. Our industrial laminates include electrical grades, fuel cell backing board, general purpose aircraft construction board and sign board.	Continental Can Company, Inc., Wilmington, Delaware
Contact	Self-adhesive labels	Archer Label Co., Los Angeles, California
Continental	Carbon black	Witco Chemical Co., New York, New York
Continex	Carbon black	Witco Chemical Co., New York, N.Y.
Cordfil	Random cut cotton, rayon or nylon cord	The Rayon Processing Co. of R. I., Pawtucket, Rhode Island
Cordo	Laquer coatings for bonding, laquer coatings for plastic sheeting	Cordo Chemical Corp., Norwalk, Conn.
Cordobond	Special purpose adhesives	Cordo Chemical Corp., Norwalk, Conn.
Cordocled	Corrosion resistant paints	Cordo Chemical Corp., Norwalk, Conn.
Cordoflex	Protective coatings	Cordo Chemical Corp., Norwalk, Conn.
Cordoglas	Plastic resins & compounds for impregnating	Cordo Chemical Corp., Norwalk, Conn.
Cordopreg	Polyester reinforced fibreglas	Cordo Chemical Corp., Norwalk, Conn.
Cordotack	Tacky adhesives	Cordo Chemical Corp., Norwalk, Conn.
Coresinblak	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Corpolin	Industrial humectant or paper plasticizer	Heyden Chem. Corp., New York, N.Y.
Cosmos & Cosmos-Chrome	Electronic sealing machines and parts thereof.	Cosmos Electronic Machine Corp., New York, New York
Cosol	Hydrocarbon Solvent	Neville Chemical Co., Pittsburgh, Pa.
Covernishblak	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Coverlac	Solvent type strip coat	Spraylat Corp., New York, New York
Covinylblack	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Cratex	Abrasive Polishing Wheels, Points, Sticks, etc.	Cratex Mfg. Co., San Francisco 5, Calif.
Crealine	Plastic Pipe	Crescent Plastics, Inc., Evansville 7, Indiana
Crest-Foam	Vinyl foam	Crest Chemical Industries Corp., Brooklyn, N.Y.
Cryptone	Zinc sulphide pigments	The New Jersey Zinc Co., New York, New York
Crystal Seal	Clear molded styrene or acrylic with back decorated for third dimensional effect.	Gits Molding Corp., Chicago, Ill.
Crystolon	Abrasive, grinding wheels, refractories	Norton Co., Worcester, Mass.
Cub-line	Flexographic Printing Press	Wolverine Paper Converting Machinery Corp., Detroit, Michigan
Cub-Printer	Flexographic Printing Press	Wolverine Paper Converting Machinery Corp., Detroit, Michigan

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Curry Arts Laminations	Acrylic Decorative sheets, acetate and vinyl laminations, plexiglas fabrications	Curry Arts Laminating Co., Scranton, Pa.
Cush-N-Bio	Hand tool line	New Plastic Corp., Los Angeles, Calif.
Cycolac	Thermoplastic molding cmpds.	Marbon Chemical Div., Borg-Warner Corp., Gary, Indiana
Cymel	Melamine molding compounds and resins	Plastics & Resins Div., American Cyanamid Co., New York, N.Y.
	D	
DPR	Natural Depolymerized Rubber	H. V. Hardman Co., Inc., Belleville, New Jersey
Dacron	Polyester Fiber	E. I. du Pont de Nemour & Co., Inc., Wilmington, Delaware
Dake	Presses	Dake Corp., Grand Haven, Mich.
Dapon	Thermosetting resin	Ohio-Apex Div., Food Machinery & Chemical Corp., Nitro, West Virginia
Darex	Plasticizer, Polyvinyl Acetate Emulsion, High Styrene Copolymer Latex, High Styrene Copolymer Resin.	Dewey and Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass.
Davis-Standard	Thermoplastic and rubber extruding machine and accessories	Davis-Standard, Div. of Franklin Research Corp., Mystic, Conn.
Daxad	Dispersing agent, either sodium or potassium salts of alkyl naphthalene sulfonic acid also by differing numbers, they are polymerized sodium salts of substituted benzoid alkyl sulfonic acid.	Dewey and Almy Chemical Co., Cambridge, Mass.
Day	Pony mixers, Dispersion or Roll Mills, Blenders, Imperial Dispersion Mixers, Sifters, Heavy Duty Double Arm Mixers.	J. H. Day Co., Cincinnati, Ohio
Daycor	Corrugated and Flat Sheet for non-structural uses.	Strick Plastics, Perkasie, Pennsylvania.
Decalin	Solvent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Decor-Vac	Decorative Vacuum Formed Plastics.	W. L. Stenagaard and Associates, Inc., Chicago, Illinois
Densite	Gypsym cement—high strength	Beatwall Certain-Teed Sales Corp., Ardmore, Pennsylvania
Derbylite	Daylight—fluorescent molding powders and products	Luminous Resins, Inc., Chicago, Ill.
Devcon	80% Steel-20% Plastic for making Molds.	Chemical Development Corp., Danvers, Mass.
Dexstar	Long fibre specialty papers	C. H. Dexter & Sons, Inc., Windsor Locks, Conn.
Diall	Diallyl phthalate molding compounds	Mena Plastics Co., Los Angelea, California
Diamond	Vulcanized Fibre Sheets, rods, tubes	Continental-Diamond Fibre Corp., Newark, Delaware
Diatol	Denatured alcohol solvent	U. S. Industrial Chemicals Co., Div. of National Distillers and Chemical Corp., New York, New York
Dilecto	Laminated Plastic sheets, rods, tubes	Continental-Diamond Fibre Corp., Newark, Delaware
Dimetcote	Protective coating	Amercoat Corp., South Gate, California
Dispersions	Plastics Dispersion	Badische Anilin- & Soda Fabrik A. G., Germany
Diorid	Polyvinylidene chloride for production of filaments	Badische Anilin- & Soda Fabrik A. G., Germany
Dipentek	Dipentaerythritol technical	Heyden Chem. Corp., New York, N.Y.
Disperbite	Aqueous dispersions of rubber	Naugatuck Chemical, Div. of the U.S. Rubber Co., Naugatuck, Conn.
Donwood	Electrical and plastic	Sierra Electric Corp., Gardena, Calif.
Dorey	Metalized Mylar laminates	The Dorrie Process Co., Inc., Brooklyn, New York
Dorr	Vinyl film and sheeting and coated fabrics	Gordon-Lacy Chemical Products Co., Inc., Maspeth, L.I., N.Y.
Dow Corning	Silicone products	Dow Corning Corp., Midland, Mich.
Dropex	Plasticizers for Vinyl Resins	Argus Chemical Laboratory, Brooklyn, N.Y.
Drycal	Pigments for coloring Plastics	Gering Products, Inc., Kenilworth, N. Jersey
Dryply	Pre-impregnated polyester glass cloth and mat	Flexfirm Products, El Monte, Calif.
Duco	Enamels, Finishes, Lacquer Sealers	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Du Lite	Enamels	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Dulux	Foam Resin, Paints, Varnishes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Duol	Resinated chemical pigments	E. I. du Pont de Nemours & Co., Inc., Pigment Div., Wilmington, Del.
Duponol	Sodium Lauryl Sulfate, Surface Active Agents	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Duralon	Furane Resins	U. S. Stoneware Co., Akron, Ohio
Duratex	Supported vinyl fabric for automotive seatcovers and automotive trim.	Textileather Division, The General Tire & Rubber Co., Toledo, Ohio
Durex	Pipe and Fittings	Franklin Plastics, Inc., Franklin, Pennsylvania
Durez	Diallyl phthalate molding compounds, Phenolic resins, Phenolic molding compounds, Polyester molding compounds, Polyester resins (fire-retardant).	Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, New York
Dyal	Alkyd and Styrenated Alkyd Resins for Coatings	Sherwin-Williams Company, Pigment, Color and Chem. Div., New York, N.Y.
Dyfoam	Foam plastic insulation	Dyfoam Corp., New Castle, Pennsylvania
Dylan	Polyethylene	Koppers Company, Inc., Chemical Division, Pittsburgh, Pa.
Dylene	Polystyrene	Koppers Company, Inc., Chemical Division, Pittsburgh, Pa.
Dylite	Expandable polystyrene	Koppers Company, Inc., Chemical Division, Pittsburgh, Pa.
Dymal	Maleic Resins for Coatings	The Sherwin-Williams Co., New York, New York
Dynatherm	Electronic (dielectric) heating and sealing presses, ovens, and all related work handling equipment.	Guild Electronics Inc., New York, New York
Dyphene	Phenol-Formaldehyde Pure Resins for Coatings	Sherwin-Williams Co., Pigment, Color and Chem. Div., New York, N.Y.
Dyphenite	Phenol-formaldehyde, Modified Resins for Coatings	Sherwin-Williams Co., Pigment, Color and Chem. Div., New York, N.Y.
Dytron	Laminated Fabric	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
	E	
Eccofoam	Foam products	Emerson and Cuming, Inc., Canton, Mass.
Eccosorb	Series of electromagnetic energy absorbers	Emerson & Cuming, Inc., Canton, Mass.
Elastofoam	Series of patented vinyl plastisol compounds	Elastomer Chemical Corp., Newark, N.J.
Elastolex	Elastic fabric supported vinyl	Texileather Division, The General Tire & Rubber Co., Toledo, Ohio
Electromax	Temperature Signalling Controller	Leeds & Northrup Co., Philadelphia, Pennsylvania
Electronheat	Dielectric Preheating Generators	Rendel Engineering Corp., Pasadena, Calif.
Elf	Channel Carbon Blacks	Godfrey L. Cabot, Inc., Boston, Massachusetts
Elftex	Oil Furnace Carbon Blacks	Godfrey L. Cabot, Inc., Boston, Massachusetts
Elmer's	Adhesives	The Borden Co., Chemical Div., New York, New York
Elmes	Hydraulic presses and equipment	Elmes Engineering Div., American Steel Foundries, Cincinnati, Ohio
Elprine	Rubber-Base coating	Atlas Mineral Products Co., Mertztown, Pennsylvania
Elvacet	Polyvinyl Acetate Emulsion	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Elvanol	Polyvinyl Alcohol	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Emerox	Azlaic Acid	Emery Industries, Inc., Cincinnati, Ohio
Emersol	Stearic and oleic acids	Emery Industries, Inc., Cincinnati, Ohio
Empol	Polymerized Acids	Emery Industries, Inc., Cincinnati, Ohio
Emulphor	Surfactant; emulsifying agent; latex stabilizer; antistatic agent.	Antara Chemicals, Div. of General Aniline & Film Corp. New York, New York
Emu-Pulver 120 FD	Styrene-containing mixed polymers, re-emulsifiable in water, for the production of aqueous dispersions for paints.	Badische Anilin- & Soda Fabrik A. G., Germany
Endura	Impregnated and coated papers	Endura Corp., Quakertown, Pennsylvania
Ensolex	Cellular plastic material in sheet form or extruded shapes for the construction industry.	United States Rubber Co., New York, New York.
Ensolite	Cellular plastic material in sheet form and extruded shapes	United States Rubber Co., New York, New York
Entoleter	Impact Mill and/or Centrifugal Mixer	Entoleter Div., Safety Industries, Inc., New Haven, Conn.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Epco	Drum tumblers and masterbatch (predispersed pigment in polyethylene)	Erie Plastics Co., Div. of Erie Iron & Supply Corp., Erie, Pa.
Epibond	Synthetic resins for use in adhesives	Furane Plastics, Inc., Los Angeles, Calif.
Epikote	Epoxy Resin	Shell Chemical Corp., New York, New York
Epi-Rez	Epoxy Resins	Jones-Dabney Co., Louisville, Ky.
Epi-Tex	Epoxy Ester Resins	Jones-Dabney Co., Louisville, Ky.
Epi-Ver	Epoxy Ester Resins	Jones-Dabney Co., Louisville, Ky.
Epocast	Casting, bonding and laminating resins	Furane Plastics, Inc., Los Angeles 39, Calif.
Epon	Epoxy resin for coatings, potting, laminating, adhesives and tool and die fabrication.	Shell Chemical Corp., New York, New York.
Epon Curing Agent	Hardeners for epoxy resin systems	Shell Chemical Corp., New York, New York
Eponite	Epoxy resin for textile treating	Shell Chemical Corp., New York, New York
Epoxylite	Epoxy resin formulations	The Epoxylite Corp., El Monte, Calif.
Erdco	RF generators for plastic sealing and presses.	Erdco Engineering Corp., Addison, Illinois.
Ethocel	Ethylcellulose	Dow Chemical Co., Midland, Mich.
Ethylac	Vulcanizing Agt.	Pennsylvania Salt Manufacturing Co., Industrial Div., Philadelphia, Pennsylvania
Everflex	Vinyl Acetate Copolymer Emulsion	Dewey and Almy Chemical Co., Div. of W. R. Grace & Co., Cambridge, Mass.
Exact Weight	Scales, Industrial and Commercial	Exact Weight Scale Co., Columbus, Ohio
Excelsior	Carbon Black	Columbian Carbon Co., New York, New York
Extrudolite	Embossed extruded sheets—Styrene, acrylics, etc.	Rotuba Extruders, Inc., Brooklyn, N.Y.
	F	
FA	Furfuryl Alcohol	The Quaker Oats Co., Chemicals Dept., Chicago, Illinois
Fabricfil	Chopped fabrics for filler in plastics.	The Rayon Processing Co. of Rhode Island, Pawtucket, R. I.
Fabrez	Urea-Formaldehyde Textile Resins	Reichhold Chemicals, Inc., White Plains, New York
Fabrikoid	Pyroxylin Coated Fabrics	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Fabrilite	Vinyl coated fabrics	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Fade-Ometer	Testing Apparatus, Accelerated Fading.	Atlas Electric Devices Co., Chicago, Illinois.
Fairprene	Synthetic Rubber Coated Fabrics	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Fairylite	Plastic Cellulose Derivative in Class 1 raw or partly prepared materials.	Shoe Form Co., Inc., Auburn, New York
Farlite	Decorative & Industrial High-pressure Laminated Plastics	Plastics Div., Farley & Loetscher Mfg. Co., Dubuque, Iowa
Farrel	Mills and Calenders	Farrel-Birmingham Co., Inc., Ansonia, Conn.
Farrel-Birmingham	Mills and Calenders	Farrel-Birmingham Co., Inc., Ansonia, Conn.
Fedaron	Polyvinyl chloride coated fabric	Federal Industries, Div. of Textron, Inc., Belleville, New Jersey
Feather Brand	Balsa cores for reinforced plastics.	International Balsa Corp., Jersey City, N.J.
Fedlastic	Polyvinyl chloride coated jersey	Federal Industries, Div. of Textron, Inc., Belleville, New Jersey
Fedroid	Pyroxylin coated fabric	Federal Industries, Div. of Textron, Inc., Belleville, New Jersey
Fedrolon	Polyvinyl chloride coated fabric	Federal Industries, Div. of Textron, Inc., Belleville, New Jersey
Fedwall	Polyvinyl chloride coated fabrics	Federal Industries, Div. Textron, Inc., Belleville, New Jersey
Ferrotron	Magnetic plastic materials	The Polymer Corp., Reading Pennsylvania
Fibercast	Reinforced Epoxy Pipe, Tubing and Fittings	The Fibercast Corp., Sand Springs, Oklahoma
Fibercore	Glass fiber reinforced molding compounds	Plumb Chemical Corp., Philadelphia, Pennsylvania
Fiberesin	Laminated Decorative Board and panel stock	Fiberesin Plastics Co., Oconomowoc, Wisconsin
Fiberite	Reinforced phenolic and Melamine Molding Materials	The Fiberite Corp., Winona, Minn.
Fiberthin	Coated Textile Fabric	United States Rubber Co., New York, New York
Fibrex	Fiber glass and Premix molding compound and molded parts.	General Plastics Corp. and General Fiber, Inc., Div. of General Plastics Corp., Los Angeles, Calif.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Filfloc	Random cut fibre for filler in plastics.	The Rayon Processing Co. of R. I., Pawtucket, R. I.
Filon	Translucent Fiberglass Reinforced Plastic Building Panel	Filon Plastics Corp., El Segundo, Calif.
Firco	Plastic treatment for fire hose . . . to prevent mildew & prolong life of hose.	General Plastics Mfg. Co., Tacoma, Wash.
Fire-Snuf	Flame Retardant Polyester Translucent Structural Panels.	Resolite Corp., Zelienople, Pennsylvania
Firestone Butaprene	Composition of synthetic rubber or rubber-like materials with or without natural rubber.	Firestone Plastics Co., Pottstown, Pa.
Firestone Exon	Raw or partly prepared plastic resins in the form of powders, granules, pellets, plastisols, or lattices for further use in the industrial arts.	Firestone Plastics Co., Pottstown, Pennsylvania
Firestone Valon	Vinyl film, sheeting, monofilaments and multifilament yarns	Firestone Plastics Co., Pottstown, Pennsylvania.
Flawmaster	A thermosetting compound used to reclaim metal parts and castings, otherwise rejected for surface flaws.	Carl H. Biggs Co., Inc., Los Angeles, Calif.
Flexaust	Flexible hose for dust collections, etc.	The Flexaust Co., New York, New York
Flexbond	Polyvinyl Acetate Emulsion	Colton Chemical Co., Div. Air Reduction Co., Inc., Cleveland, Ohio
Flex-I-Base	Bases of rubber and fabric for rubber cushions	United States Rubber Co., New York, New York
Flexol	Plasticizers	Carbide and Carbon Chemicals Co., New York, New York
Flex-O-Timer	Time-cycle controller	Taylor Instrument Companies, Rochester, New York
Flexrite Colors	Lacquer Colors	Flexcraft Industries, Newark, New Jersey
Flex Span	Liquid plastic-coating	Flexcraft Industries, Newark, New Jersey
Flextherm	Hot or cold therapeutic bandage.	Skyline Industries; Skyline Plastic Pipe, Inc; Skyline Plastic Molding, Inc., Titusville, Pennsylvania
Flo-Line	Pipe made of intermediate density Polyethylene.	Skyline Industries, Skyline Plastic Pipe, Inc., Skyline Plastic Molding, inc., Titusville, Pennsylvania
Florence	Zinc oxides	The New Jersey Zinc Co., New York, New York
Fluid-Feed	Rotary table & drill press feed.	Mead Specialties Co., Inc., Chicago, Illinois
Fluoroflex	Products made from Fluorocarbon Resins	Resistoflex Corp., Roseland, New Jersey
Fluoumseal	Pipe thread compound for plastic and steel joints, resistant to chemical attack and joints can be easily disassembled.	Industrial Plastic Fabricators, Inc., Norwood, Mass.
Fluran	Fluocarbon Products	U. S. Stoneware Co., Akron, Ohio
Forasite	Phenol-Formaldehyde Particle Board Adhesives	Reichhold Chemicals, Inc., White Plains, New York
Formacurve	Formed decorative laminated plastic materials.	Pine-Wood Plastic Co., Inc., Cambridge, Mass.
Formvar	Polyvinyl formal resins	Shawinigan Resins Corp., Springfield, Mass.
Fortical	Cellulosic Plastic	Plastics Div., Celanese Corp. of America, Newark, New Jersey
Fortiflex	Polyolefin Resin	Plastics Div., Celanese Corp. of America, Newark, New Jersey
Fostarene	Polystyrene	Foster Grant Co., Inc., Leominster, Mass.
Foundrez	Urea-Formaldehyde and Phenol-Formaldehyde Foundry Resins	Reichhold Chemicals, Corp., White Plains, New York
Franklin	Hard Vulcanized Fibre	Franklin Fibre-Lamitex Corp., Wilmington, Delaware
Fray-No	Fray proofing	Farrington Texol Corp., Walpole, Mass.
Fray-No-Therm	Heat sealable coating	Farrington Texol Corp., Walpole, Mass.
Fulscope	Indicating or Recording Controllers for temperature and pressure.	Taylor Instrument Companies, Rochester, New York
Fuse Film	Film and film laminate	Velveray Corp., New York, New York
Fyberoid	Very high grade insulating paper commonly called "Fish Paper."	Wilmington Fibre Specialty Co., New Castle, Dela.
	G	
G-K	Pipe joint compound	Atlas Mineral Products Co., Mertztown, Pennsylvania
Gelo	Casein	George Morrell Corp., Muskegon Heights, Mich.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Golorn	Casein	George Morrell Corp., Muskegon Heights, Mich.
Gomaco	Natural calcium carbonate extender water ground from White Georgia Crystalline.	The Calcium Products Div., The Georgia Marble Co., Tate, Georgia
Goralease	Mold release Laeguers	Garan Chemical Corp., Gardena, Calif.
Goralyst	Catalyst compositions	Garan Chemical Corp., Gardena, Calif.
Goran Goranized Goran Finish Garden Beauty	Glass fiber roving " " " " " " Extruded rigid vinyl garden fencing, stakes and trellises.	L. O. F. Glass Fibers Co., Toledo, Ohio Gering Products, Inc., Kenilworth, New Jersey
Gorox	Peroxide Compositions.	Garan Chemical Corp., Gardena, Calif.
Gel-Kote	Coating for polyester products. (molded with product).	The Glidden Co., Cleveland, Ohio
Gelva	Polyvinyl acetate resins	Shawinigan Resins Corp., Springfield, Mass.
Gelvatex	Aqueous polyvinyl acetate emulsions and paint bases and paints compounded therefrom.	Shawinigan Resins Corp., Springfield, Mass.
Gelvatol	Polyvinyl alcohol resins	Shawinigan Resins Corp., Springfield, Mass.
Gemacite	Molding of a thermosetting plastic for decorative articles.	Greene Plastics Corp., Hope Valley, R. I.
Gemwood	Laminated sheets consisting of pregwoods combined with plastic sheets, acrylic, phenolic, acetate, etc.	Gemwood Corp., Jamaica, N.Y.
Gen-Flo	Styrene Butadiene Latex	Chemical Div., General Tire & Rubber Co., Akron, Ohio
Genofil-Rohre	Unplasticized rigid-Tubing for pipes and structural uses in all colors.	Anorgana G.M.B.H. Munchen, Ger.
Genotex	Yarn for weaving of fine plastic textiles.	Anorgana G.M.B.H. Munchen, Germany
Genotherm	Unplasticized vinyl film-sheet-plate, from .0006" to .020" in rools-calendered-non toxic.	Anorgana G.M.B.H. Munchen, Germany
Gen-Tac	Rubber-to-fabric Vinyl Pyridine Adhesive Dip	Chemical Div., General Tire & Rubber Co., Akron, Ohio
Genton	Dispersions of Synthetic Resins.	General Dispersions, Inc., Paterson, New Jersey
Geon	Polyvinyl Chloride resins, compounds, and latices.	B. F. Goodrich Chemical Co., Cleveland, Ohio
Gen-Flex	Vinyl tubing	Gering Products, Inc., Kenilworth, New Jersey
Gerlite	Acrylic sheeting	Gering Products, Inc., Kenilworth, New Jersey
Gen-Pak	Polyethylene film	Gering Products, Inc., Kenilworth, New Jersey
Gen-Tube	Polyethylene tubing	Gering Products, Inc., Kenilworth, New Jersey
Gilco	Polystyrene Sheets, Polyethylene-roll and sheets	The Gilman Bros. Co., Gillman, Conn.
Glas-Bond	Adhesives	Polymer Industries, Inc., Springdale, Conn.
Glaskyd	Alkyd molding compounds	Glaskyd Inc., Perryaburg, Ohio
Glastic	Fiberglass reinforced plastics-flat sheets laminates, premix custom moldings, extruded rod stock, stator slot wedges.	The Glastic Corp., Cleveland, Ohio
Glasticote	A non-flammable liquid for cleaning, polishing and protecting plastic and glass surfaces. A light buffing compound for use on plastics. A mild release liquid for plastics.	Industrial and Domestic Silicone Distributor, Reseda, California
Glidpol	Basic material for molding, laminating, etc., of reinforced plastic products.	The Glidden Co., Cleveland, Ohio
Glitex	Plastic tubing for electrical insulation.	Genesee Laboratory, Inc., Auburn, New York
Globalite	Fluorescent Molding Powders and Products	Luminous Resins, Inc., Chicago, Illinois
Globlak	Carbon Black Dispersions	Columbian Carbon Co., New York, New York
Glykon	Polyester Resin	Chemical Div., General Tire & Rubber Co., Akron, Ohio
Glyptal	Pigmented resin-base paints, varnishes, enamels, alkyd resins.	Chemical Materials Dept., General Electric Co., Pittsfield, Mass.
Goldcote	Gold colored vacuum metalized finish.	The Eyelet Specialty Co., Waterbury, Conn.
Golpanol	Protective coating for metal and anti-corrosive metal.	Badische Anilin- & Soda Fabrik A. G., Germany
Goodallite	Vinyl coated fabrics	Goodall-Sanford, Inc., Reading, Mass.
Good-Rite	Chemicals	B. F. Goodrich Chemical Co., Cleveland, Ohio
Goodstix	Self sticking printed transparent advertising signs and product labels.	Goodrich Products Corp., Englewood, New Jersey
Grandur	Decorative plastic laminated furniture products.	Pine-Wood Plastic Co., Inc., Cambridge, Mass.
Grex	Linear (high density) Polyethylene	W. R. Grace & Co., Polymer Chemicals Div., Clifton, New Jersey

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Grip Flex	Special Decorative Coatings	Keystone Refining Co., Inc., Philadelphia, Pennsylvania
Guard	Vinyl wall covering	Columbus Coated Fabrics Corp., Columbus, Ohio
Gummon	Bituminous-asbestos cold molding compound. (organic)	Garfield Manufacturing Co., Garfield, New Jersey
Gusco	Epoxy and Epoxy Phenolic Coatings	A. Gushmer, Inc., Stalpic Div., Woodbridge, New Jersey
Gusher	Centrifugal pumps, Molten metal pumps	The Ruthman Machinery Co., Cincinnati, Ohio
Gusher Coolant Pump	Vertical centrifugal pump	The Ruthman Machinery Co., Cincinnati, Ohio
Guttano-Glasklar	Glass-clear-film in varying hardnesses-calendered-polished.	Anorgana G.M.B.H. Munchen, Germany
Gymseal	Clear Phenolic Floor Finish	McCloskey Varnish Co., Philadelphia, Pennsylvania.

H

H Kohnstamm Atlas HK	Pigment colors for general manufacturing purposes, including plastics.	H. Kohnstamm & Co., Inc., New York, New York
Halowax	Chlorinated naphthalenes	Union Carbide and Carbon Corp.
Hanna	Valves, riveters	Hanna Engineering Works, Chicago, Ill.
Hanna Flo-Set	Speed control waves	Hanna Engineering Works, Chicago, Ill.
Harflex	Plasticizers (adipates, sebacates, phthalates, and specialties.)	Harchem Div., Wallace & Tiernan, Inc., Belleville, N.J.
Harmon	Colors	B. F. Goodrich Chemical Co., Cleveland, Ohio
Hasko.Struct	Polyester resin impregnated fiberglass bonded to expanded foam.	Haskelite Mfg. Corp., Grand Rapids, Mich.
Haveg	Filled phenolic resin for chemical process equipment. Filled furan resin for chemical process equipment	Haveg Industries, Inc., Wilmington, Delaware
Haysite	Reinforced polyester	Hays Mfg. Co., Erie, Pennsylvania
Hextrex	Clear and pigmented baking lacquer	Rexton Finishes, Inc., Irvington, New Jersey
Heirloom	Alkyd Protective Coating	McCloskey Varnish Co., Philadelphia, Pennsylvania
Heliogen	Blue and green copper-phthalocyanine pigments.	General Dyestuff Co., Sales Div. of General Aniline & Film Corp., New York, New York
Heliozone	Inhibitor	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Hemit	Cement-asbestos cold molding compound. (inorganic)	Garfield Mfg. Co., Garfield, New Jersey
Hercocel	Cellulose acetate molding powder, ethyl cellulose molding powder.	Hercules Powder Co., Inc., Wilmington, Delaware
Herculflex	Plasticizers	Hercules Powder Co., Inc., Wilmington, Delaware
Hercolyn	Hydrogenated methyl abietate	Hercules Powder Co., Inc., Wilmington, Delaware
Hercules	Interchanging type holder	The Acromark Co., Elizabeth, New Jersey
Heresyn	Butadiene-Acrylonitrile Synthetic Rubber	Heresite & Chemical Co., Manitowoc, Wis.
Heresite	Phenolic coatings	Heresite & Chemical Co., Manitowoc, Wis.
Hetron	Polyester resins (fire-retardant)	Hooker Electrochemical Co., Durez Plastics Div., North Tonawanda, New York
Hexcel	Structural honeycomb material	Hexcel Products, Inc., Oakland, Calif.
Hexcelite	Decorative paneling using Hexcel aluminum honeycomb and window glass.	Hexcel Products, Inc., Oakland, Calif.
Hi-fax	Linear polyethylene	Hercules Powder Co., Inc., Wilmington, Pennsylvania
Hi-Line	Pipe made of linear Polyethylene	Skyline Industries; Skyline Plastic Pipe, Inc., Skyline Plastic Molding, Inc., Titusville, Pennsylvania
Hobe	Honeycomb before expansion	Hexcel Products, Inc., Oakland, Calif.
Horse Head	Zinc pigments, titanium dioxide pigments	The New Jersey Zinc Co., New York, New York
Hyben	Plastic sheeting, textile coating	Associated Rubber and Plastic Corp., New York, New York
Hycar	Acrylonitrile, polyacrylic, butyl, and styrene rubbers and latices.	B. F. Goodrich Chemical Co., Cleveland, Ohio
Hycryl	Modified Ammonium Polyacrylate Solution	U B S Chemical Corp., Cambridge, Mass.
Hydrite	Extender and inert filler pigment	Georgia Kaolin Co., Elizabeth, New Jersey
Hydro-Finish	Liquid blast machine used for cleaning molds, dies, etc.	Pangborn Corp., Hagerstown, Md.
Hydro-Line	Flexographic Printing Press	Wolverine Paper Converting Machinery Corp., Detroit, Mich.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Hydro-Printer	Flexographic Printing Press	Wolverine Paper Converting Machine Corp., Detroit, Mich.
Hylene	Organic isocyanates	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Hypalon	Synthetic rubber	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Hypervac	High vacuum pumps	Central Scientific Co., Chicago, Ill.
Hysol	Epoxy Resin Compounds and Amine and Anhydride Hardeners	Houghton Laboratories, Inc., Olean, New York
Hyvac	High vacuum pumps	Central Scientific Co., Chicago, Ill.
	I	
Igepal	Surfactant; emulsifier; antistatic agent; wetting agent.	Antara Chemicals, Div. of General Aniline & Film Corp., New York, New York
Igepon	Surfactant; wetting agent	Antara Chemicals, Div. of General Aniline & Film Corp., New York, New York
Im-Plast	High impact chemical resistant thermosetting plastic material used for containers for electrical storage batteries, etc.	The Richardson Co., Melrose Park, Ill.
IMS	Tumblers, grinders and machinery items. IMS mold release: zinc stearate dry powder, silicone sprays.	Injection Molders Supply Co., Cleveland, Ohio
IN	Radiation gauges used in measuring the physical properties of materials. Control equipt.	Industrial Nucleonics Corp., Columbus, Ohio
Ind	Thermosetting & Thermoplastic molding materials	Industrial Molded Products Co., Inc., Palatine, Ill.
Indur	Phenolic Molding Material	Pitt-Consol Chemical Co., Newark, New Jersey
Insultruc	Fiberglas polyester laminate.	Cincinnati Development & Manufacturing Co., Cincinnati, Ohio
Insurok	Laminated plastic sheet, tubes, gears, blanks, washers, discs, special punched and molded parts.	The Richardson Co., Melrose Park, Ill.
Interplastics	Thermoplastic Molding Powders	Interplastics Corp., New York, New York
Iolyte	Reinforced Plastic Fabrications	Schori Process, Div. Forro-co Corp., N.Y., N.Y.
Isasol	Solvent Soluble Dyes	National Aniline Div., Chemical & Dye Corp., New York, New York
Iporka	Urea resin and foam	Badische Anilin- & Sofa Fabrik, A. G., Germany
Irvinil	Polyvinyl chloride resin	Great American Plastics Co., Fitchburg, Mass.
Isanol	Lacquer solvent	Badische Anilin- & Soda Fabrik A. G., Germany
Isolite	Polyester Resins	Schenectady Varnish Co., Inc., Schenectady, New York
Isomelt	Polyurethane Wire Enamel	Schenectady Varnish Co., Inc., Schenectady, New York
Isonel	Polyester Wire Enamel	Schenectady Varnish Co., Inc., Schenectady, New York
Isoplast	Depolymerized rubber	Rubber & Asbestos Corp., Bloomfield, New Jersey
Isotemp Ovens	Ovens	Fisher Scientific Co., Pittsburgh, Pennsylvania
Ivo	Bone black	Columbian Carbon Co., New York, New York
	J	
JC-60	Pipe Joint Compound	Atlas Mineral Products Co., Mertztown, Pennsylvania
Jarco 88	Prelubricated nylon compound	Jim Robbins Co., Royal Oak, Mich.
Javelle	Citronella odorant	Fritzsche Brothers, Inc., New York, New York
Jek-o-mer	Liquid alkyd resin and solutions thereof both for use as coating compositions and as vehicles in making paints and enamels—additive for making thixotropic paints.	Alkydor Laboratories, Inc., Cicero, Ill.
Jet-Kote	Furane Resin Coatings	Furane Plastics, Inc., Los Angeles, Calif.
Jodo	Plastic materials and synthetic resin	Joseph Davis Plastics Co., Arlington, New Jersey
Johnson's	Prepared wax in paste, liquid, powdered form.	S. C. Johnson & Son, Inc., Racine, Wis.
Johnson's Wax	Wax products used as mold release agents.	S. C. Johnson & Son, Inc., Racine, Wis.
Jumbo Plate	Electrical and Plastic	Sierra Electric Corp., Gardena, Calif.
	K	
Kadox	Zinc oxides	The New Jersey Zinc Co., New York, New York
Kalite	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Kapsol	Plasticizers-oleate plasticizer	Ohio-Apex, Div. F.M.C., Nitro, W. Va.
Kaurit-Leim	Condensation product based on urea-formaldehyde; used for strong adhesion; waterproof.	Badische Anilin- & Soda Fabrik A. G., Germany
Kel-F	Molding powder & molded products. Polymer oils, greases, & waxes.	The M. W. Kellogg Co., Jersey City, New Jersey
Kendent	Diamond indenter for hardness testers	The Torsion Balance Co., Clifton, New Jersey
Kenflex	Synthetic Resin	Kenrich Corp., Maspeth, New York
Kentrall	Rockwell Type Hardness tester for both regular and superficial tests.	The Torsion Balance Co., Clifton, New Jersey
Kentron	Micro hardness tester	The Torsion Balance Co., Clifton, New Jersey
Keratol	Pyroxylin coated bookbinding fabric.	The General Tire & Rubber Co., Textileather Div., Toledo, Ohio
Kessco	Fatty Acid Ester and Plasticizers	Kessler Chemical Co., Inc., Philadelphia, Pennsylvania
Kleercor	Simultaneous extrusion of polyethylene pipe with a clear interior core and a black extruded sheath.	Western Plastic Corp., Hastings, Nebraska.
King Designers	Plastic & Die Cast Mold Design Engineers Plastic Consultants.	King Designers, Detroit, Mich.
Kling-Seal	Thermoplastic coated sheet material	Milprint, Inc., Milwaukee, Wis.
Ko-Blend	Insoluble Sulfex-GR-s Master Batch	General Tire & Rubber Co., Chemical Div., Akron, Ohio
Kodapak	Transparent sheeting	Eastman Kodak Co., Rochester, New York
Kopal	Processed Congo Copals	Reichhold Chemicals, Inc., White Plains, New York
Korasin	Vinyl resin on a phenolic base for the rubber industry.	Badische Anilin- & Soda Fabrik A. G., Germany
Korex	Rubber-Base Coating	Atlas Mineral Products Co., Mertztown, Pennsylvania
Koroseal	Plastisol compounds for sewer tile industry and rack coating industry.	The B. F. Goodrich Industrial Products Co., Div. B. F. Goodrich Co., Akron, Ohio
Korosheal	Vinyl coated fabric, vinyl film and sheet, vinyl flexible extrusions, vinyl pipe, fittings, sheet, rod, and tubing.	B. F. Goodrich Industrial Products Co., Plastic Div., Marietta, Ohio
Ketol	Solvent solutions of synthetic resins for protective coatings on machinery and tank linings.	Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Kralac	Thermoplastic resins for molding and forming.	Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Kralastic	Molding and extrusions compounds	Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Krene	Vinyl chloride-acetate calendered film and sheeting. Vinyl cast film.	Union Carbide and Carbon Corp.
Kromoplast	Dry colorant for thermoplastics	American Molding Powder & Chemical Corp., Brooklyn, N.Y.
Kronisol	Dibutixyethyl phth. plasticizer.	Ohio-Apex, Div. F.M.C., Nitro, W. Va.
Kronitex	Tricrisyl phophliate plasticizer	Ohio-Apex, Div. F.M.C., Nitro, W. Va.
Krylon	Plastic coating	Krylon, Inc., Norristown, Pennsylvania
Kure-Blend	Tetramethyl Thiuramdisulfide-GR-s	General Tire & Rubber Co., Chemical Div., Akron, Ohio
Kunsthars	Unsapohifiable synthetic resin, based on ketones, for weatherfast oil, alkyd, and nitrocellulose lacquers. Alcohol-soluble resin for nitrocellulose. Alcohol-soluble synthetic resin for waterproof nitrocellulose wood lacquers and nitrocellulose acetate lacquers.	Badische Anilin- & Soda Fabrik A. G., Germany
Kyo-lite	Resin-Gearing Fibrous Articles	Keyes Fibres Co., Waterville, Maine
	L	
Labelon	Tape, pressure-sensitive labels.	Labelon Tape Co., Inc., Rochester, New York
Lacrinoid	Finishing and Polishing Materials	Lacrinoid Products, Ltd., Essex, England

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Ledcote Compounds	Thermoplastic compounds	L. A. Dreyfuss Co., South Plainfield, New Jersey
Lemin-Art	Decorative Laminates	Fabricon Products, Div. The Eagle-Pitcher Co., River Rouge, Mich.
Leminac	Polyester Resins	American Cyanamid Co., Plastics & Resins Div., New York, New York
Lemitex	Laminated bakelite	Franklin Fibre-Lamitex Corp., Wilmington, Delaware
Lercrylic	Acrylic plastic sheet.	Larc Products, Inc., Amsterdam, New York
Leromin	Hardener for epoxies	Badische Anilin- & Soda Fabrik A. G., Germany
Leropal	Modified...ester for rapidly drying oil, alkyd, alcohol lacquers, etc.	Badische Anilin- & Soda Fabrik A. G., Germany
Letekoll	Thickening agent for dispersions	Badische Anilin- & Soda Fabrik A. G., Germany
Letyl	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Layflat	Plastic tubing	Plax Corp., Hartford, Conn.
Lauxite	Melamine, urea, phenolic and resorcinal resin adhesives.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Leefluor	Teflon rods, sheets, tubes and molded fabricated parts.	Walt Lee Chemical Corp., Bronx, New York
Lemac	Polyvinyl acetate	The Borden Co., Chemical Div., New York
Lemol	Polyvinyl alcohol	The Borden Co., Chemical Div., New York, New York
Leucogen	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Leucosol	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Lignocol	Anti-Skinning Agent	Heyden Newport Chemical Corp., New York, New York.
Lignofol	Compregnated Laminated wood	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Lilion	Transmission belts, filters, wicks, gaskets, wiping cloths, and electronic or heat sealings.	Pellon Corp., New York, New York
Lithosol	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Logo	Solutions of organic polymeric substances to be used for surface treatment for plastics.	Logo, Inc., Chicago, Ill.
Logofoil	Strippable protective coating and composition.	Logo, Inc., Chicago, Ill.
Logoquant	Chemical Preparations, protective coating compositions for use on plastic articles.	Logo, Inc., Chicago, Ill.
Logoset	Synthetic enamels and varnishes	Logo, Inc., Chicago, Ill.
Lorol	Normal cetyl alcohol	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.
Lotol	Compounded latices	Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Loxite	Elastomeric Adhesives	Xylos Rubber Co., Div. of Firestone Tire & Rubber Co., Akron, Ohio
Lucktin	Rapidly evaporating surface coating for oil and alkyd lacquers.	Badische Anilin- & Soda Fabrik A. G., Germany
Lucidol	Benzoyl Peroxide	Wallace & Tiernan, Inc., Lucidol Div., Buffalo, New York.
Lucite	Acrylic Resin	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Lumarith	Cellulosic plastic	Celanese Corp. of America, Plastics Div., Newark, New Jersey
Luperco	Organic Peroxide Compounds	Wallace & Tiernan, Inc., Lucidol Div., Buffalo, New York
Lumigraphic	These cover a range of shades from red, orange, yellow, and green fluorescent pigments.	Imperial Paper and Color Corp., Pigment Color Div., Glens Falls, N.Y.
Luperox	Organic Peroxide Pastes	Wallace & Tiernan, Inc., Lucidol Div., Buffalo, New York
Lupersol	Organic Peroxide Solutions	Wallace & Tiernan, Inc., Lucidol Div., Buffalo, New York
Luphen	Hardenable phenolic resin for chemical resistant lacquers and acid resistant coatings.	Badische Anilin- & Soda Fabrik A. G., Germany
Lupolen	High-molecular polyethylene	Badische Anilin- & Soda Fabrik A. G., Germany
Lusano	Brilliant Blue B Dye	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Lustrelite	Patterned pearlized acrylic sheet	U. S. Plastic Products Corp., Metuchen, New Jersey
Lustretone	Heat resistant pearlized button stock	U. S. Plastic Products Corp., Metuchen, New Jersey
Lutofan	Synthetic dispersions and solutions for paper and web coating.	Badische Anilin- & Soda Fabrik A. G., Germany
Lutonal	Unsaponifiable soft resins based on vinyl ether for adhesives	Badische Anilin- & Soda Fabrik A. G., Germany
Luvicon	Heat-resistant thermoplastic, specially for electronic applications	Badische Anilin- & Soda Fabrik A. G., Germany
Luxol	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Lytron	Polyelectrolyte resins and resins for use as foundry sand binders.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.

M

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
MC-1	Catalyst	Celanese Corp. of America, Plastics Div., Newark, New Jersey
M. D. A.	Methylene Disalicylic Acid	Heyden Newport Chemical Corp., New York, New York
MR	Liquid Resin	Celanese Corp. of America, Plastics Div., Newark, New Jersey
MX	Fibreglass reinforced plastic lamp and lighting parts.	Marplex Co., El Segundo, California
Magic-Vulc	Adhesives & Coatings	Magic Chemical Co., Brockton, Mass.
Man O'War Ultra Spar	Phenolic Spar Varnish	McCloskey Varnish Co., Philadelphia, Pennsylvania
Mapico	Synthetic Iron Oxide Pigments	Columbian Carbon Co., Mapico Color Unit, New York, New York
Maraset	Epoxy resins	The Marblette Corp., Long Island City, New York
Marblette	Phenolic resins	The Marblette Corp., Long Island City, New York
Marbon 8000	High Styrene Resins	Borg-Warner Corp., Marbon Chemical Div., Gary, Indiana
Marco	Liquid Synthetic Resin	Celanese Corp. of America, Plastics Div., Newark, New Jersey
Marcothix	Thixotropic Polymer	Celanese Corp. of America, Plastics Div., Newark, New Jersey
Markonic	Marking service specialist	The Acromark Co., Elizabeth, New Jersey
Marlex	Olefin Polymer	Phillips Chemical Co., Barlesville, Oklahoma.
Marmix	Resin Emulsions	Marbon Chemical Div., Borg-Warner Corp., Gary, Indiana
Marvibond	Laminated sheets of plastic on metal.	United States Rubber Co., Naugatuck Chemical Div., Naugatuck, Conn.
Marvinol	Vinyl resins and compounds	Naugatuck Chemical, Div. of United States Rubber Co., Naugatuck, Conn.
Master Color	Concentrated pigment dispersions (Master-Batch) for thermoplastics materials.	American Molding Powder & Chemical Corp., Brooklyn, N.Y.
Mead	Air devices, etc.	Mead Specialties Co., Inc., Chicago, Ill.
Meadmatic	Pneumatic Timers, valves	Mead Specialties Co., Inc., Chicago, Ill.
Mearlmaid	Natural Pearl Essence	Mearl Corp., New York, New York
Megavac	High Vacuum Pumps	Central Scientific Co., Chicago, Ill.
Melmac	Molded quality melamine dinnerware.	American Cyanamid Co., Plastics & Resins Div., New York, New York
Melurac	Resin adhesives, Melamine-Urea-Formal.	American Cyanamid Co., Plastics & Resins Div., New York, New York
Merac	Water soluble rubber Latex Accelerator	Pennsylvania Salt Mfg. Co., Industrial Div., Philadelphia, Pennsylvania
Mercadiums	Cadmium Mercury Oranges, Reds, and Maroons	Imperial Paper and Color Corp., Pigment Color Div., Glens Falls, New York
Merix Anti-Fog	Fog-Preventative Chemical for plastic and glass surface	Merix Chemical Co., Chicago, Ill.
Merix Anti-Static	De-Staticizing Chemical (plastics), Anti-Static for Fabrics & Plastic Seatcovers.	Merix Chemical Co., Chicago, Ill.
Merix TV Tele Clear	Television tubes and Lens. Destaticizer/Cleanser (plastic & glass)	Merix Chemical Co., Chicago, Ill.
Merpentine	Surface Active Agent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.
Merpol	Surface Active Agent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Metaflex	Embossed Mylar Laminated to Vinyl Coated Products Including Fabric Base.	L. E. Carpenter & Co., Wharton, New Jersey
Methac	Methanol-methyl acetate solvent	The Borden Co., Chemical Div., New York, New York

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Methocel	Methylcellulose	Dow Chemical Co., Midland, Mich.
Methox	Dimethoxyettiyl phthalate plasticizer	Ohio-Apex, Div. F.M.C., Nitro, W. Va.
Methylon	Phenolic coating resin	General Electric Co., Chemical Materials Dept., Pittsfield, Mass.
Metso	Sodium metasilicate pentahydrate, Sodium metasilicate anhydrous, Sodium orthosilicate concentrated, Sodium sesquisilicate pentahydrate	Philadelphia Quartz Co., Phil., Pa.
Micabond	Bonded mica insulating material	Continental-Diamond Fibre Corp., Newark, Delaware
Michigan Fiber-Glas Sales	Fiber-Glas Materials, Resins & Supplies	Michigan Fiber-Glas Sales, East Detroit, Mich.
Micronex	Carbon black	Columbian Carbon Co., New York, New York
Micronizer	Jet Pulverizer	Sturtevant Mill Co., Boston, Mass.
Microsurfacer	Sizing machine for surfacing thin sheeting	Buss Machine Works, Holland, Mich.
Midlon	Film and sheets in cellulose acetate, cellulose acetate butyrate, modified polystyrene, polyethylene, acrylic.	Midwest Plastic Products Co., Chicago Heights, Ill.
Milfilm	Laminated packaging material	Milprint, Inc., Milwaukee, Wis.
Mil-O-Casing	Meat casings	Milprint, Inc., Milwaukee, Wis.
Mil-O-Film	Plastic sheets, bags, & wrappers	Milprint, Inc., Milwaukee, Wis.
Mil-O-Seal	Pliofilm & Cellphane meat casings	Milprint, Inc., Milwaukee, Wis.
Mini-Jector	Injection molding machines	Newbury Industries Inc., Newbury, Ohio
Mipelon	PVC Copolymers	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Miracle	Black magic adhesive, ceramic tile cements, tub caulk, plastic underlayment, dry wall adhesive, wallboard cement, industrial adhesives & coating, insulation adhesives.	Miracle Adhesives Corp., Bellmore, New York
Mirasol	Alkyd Resins	C. J. Osborn Co., Linden, New Jersey
Mirro-Brite	Metallized, Acetate, Butyrate Polystyrene & "Mylar"	Coating Products, Englewood, New Jersey
Mobeloy	Polyester reinforced Fibreglass	Cordo Chemical Corp., Norwalk, Conn.
Mobay	Organic chemicals including isocyanates, carbamyl halides; synthetic resins including polyesters; chemical intermediates for polyurethane plastics; catalysts and other additives for use in making polyurethan plastics; polyurethan plastics foam and homogeneous polyurethane plastics.	Mobay Chemical Co., St. Louis, Mo.
Modulatic	Steam generator	Vapor Heating Corp., Chicago, Ill.
Mogul	Channel carbon black	Godfrey L. Cabot, Inc., Boston, Mass.
Moldexe F. 47	Mold Release Compound	The Moldrite Products Company, Providence, R. I.
Molgard	Internal Mold Releases	Garan Chemical Corp., Gardena, Calif.
Monarch	Medium color channel carbon black	Godfrey L. Cabot, Inc., Boston, Mass.
Monarchrome	Range of Green shades from light to deep made by co-precipitating Phthalocyanine Blue and Chrome yellow.	Imperial Paper and Color Corp., Pigment Color Div., Glens Falls, New York
Mondur	Isocyanates and synthetic resins including polyesters.	Mobay Chemical Co., St. Louis, Mo.
Monite	Casein Adhesives	Monite Waterproof Glue Co., Minneapolis, Minn.
Monofast	Textile Pigments, Plastic Compounds	H. Kohnstamm & Co., Inc., New York, New York
Monopaan	Paints, varnishes, enamels, etc.	Interchemical Corp., Finishers Div., Newark, New Jersey
Monopentek	Monopentaerythritol	Heyden Newport Chemical Corp., New York, New York
Monterey	Plastic wall tile, heavy gauge	Skyline Industries; Skyline Plastic Pipe, Inc.; Skyline Plastic Molding, Inc., Titusville, Penna.
Morflex	Plasticizers	Morton-Withers Chemical Co., Greensboro, N.C.
Moto-steel	Diaphragm operated valve motors	Taylor Instrument Companies, Rochester, New York
Mr. N	Ammonium Nitrate Fertilizer	Spencer Chemical Co., Kansas City, Mo.
Multifoam	Readers	J. A. Richards Co., Kalamazoo, Mich.
Multifex MM	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Multimatic	Automatic Dispenser	Archer Label Co., Los Angeles, Calif.
Multiplastics	Fiberglass kits for industrial repairs and boat coverings.	Curd Enterprizes, Inc., Multiplastics Div., Addison, Ill.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Multipruf	Vinyl coated fabric	Elm Coated Fabrics Co., Inc., New York, N.Y.
Multitrip	Woven Wood and Wire Containers for industrial handling.	G. B. Lewis Co., Watertown, Wis.
Multranil	Synthetic resins and catalysts for use in making polyrethane plastics.	Mobay Chemical Co., St. Louis, Mo.
Multron	Synthetic resins including polyesters.	Mobay Chemical Co., St. Louis, Mo.
Mustang	Composition supported vinyl	General Tire & Rubber Co., Textileather Div., Toledo, Ohio
Mycalex	Glass-bonded mica	Mycalex Corp. of America, Clifton, New Jersey
Myleroy	Glass bonded mica	Electronic Mechanics, Inc., Clifton, New Jersey

N

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
NP	For sheaves, quills, bobbins, twisters, and idlers.	National Plastics, Inc., Knoxville, Tennessee
NR Pliolite	Cyclized rubber coating resins	The Goodyear Tire and Rubber Co., Akron, Ohio
Naccanol	Detergent	Allied Chemical & Dye Corp., National Aniline Div., New York, New York
Naccosol	Wetting agent	Allied Chemical & Dye Corp., National Aniline Div., New York, New York
Naccotan	Dispersing Agent	Allied Chemical & Dye Corp., National Aniline Div., New York, New York
Nacrinor	Synthetic Pearl Pigments	Mearl Corp., New York, New York.
Nadic	Anhydride for Alkyds & Polyesters	National Aniline Div., Allied Chemical & Dye Corp., New York, New York
Naphthanil	Diazo Colors	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Nash	Air Compressors, Vacuum pumps	The Nash Engineering Co., South Norwalk, Conn.
Naugatex	Butadiene-Styrene latices	Naugatuck Chemicals, Div. of United States Rubber Co., Naugatuck, Conn.
Naugahyde	Vinyl coated fabric	United States Rubber Co., New York, New York
Naugalite	Coated Fabric	U. S. Rubber Co., New York, N.Y.
Naugalon	Fabrics coated with Waterproofing Material	U. S. Rubber Co., New York, N.Y.
Naugatop	Carriage cloth (fabric & rubber)	U. S. Rubber Co., New York, N.Y.
Nebony	Petroleum Hydrocarbon Resin	Neville Chemical Co., Pittsburgh 25, Pa.
Neelium	High solids neoprene coating	The Atlas Mineral Products Co., Mertztown, Pa.
Nekal	Wetting agent	Antara Chemicals, Sales Div. General Aniline & Film Corp., New York, New York
Neo-Spectra	Carbon Black	Columbian Carbon Co., New York, New York
Neoben	Neoprene high build coating	The Atlas Mineral Products Co., Mertztown, Penna.
Neomorpin	Surface Active Agent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Neozone	Rubber Antioxidants	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.
Nepoxide	Modified epoxyresin coating	The Atlas Mineral Products Co., Mertztown, Penna.
Neutroleum	Odor modifier for rubber, vinyl, and plasticizers.	Fritzsche Bros., Inc., New York, New York
Neutroscent	Perfume for surface dressing of finished plastics	Fritzsche Bros., Inc., New York, New York
Nevamar	High-pressure decorative laminates	The National Plastic Products Co., Odenton, Md.
Nevillac	Phenol-Modified Coumarone-Indene Resin	Neville Chemical Co., Pittsburgh 25, Pa.
Neville LX-685	Petroleum Hydrocarbon Resin	Neville Chemical Co., Pittsburgh 25, Pa.
Neville LX-702	Petroleum Hydrocarbon Resin	Neville Chemical Co., Pittsburgh 25, Pa.
Nevindene	Coumarone-Indene Resin	Neville Chemical Co., Neville Island, Pittsburgh 25, Pa.
Nevinol	Plasticizing Oil	Neville Chemical Co., Pittsburgh 25, Pa.
Nevsolv	Hydrocarbon Solvent	Neville Chemical Co., Pittsburgh 25, Pa.
Niacet	Vinyl Acetate	Carbide and Carbon Chemicals Co., New York, New York
Nibroc	Base stock for high pressure laminates	Brown Co., Boston, Mass.
Nicoform	Electroformed molds for plastics	Electromold Corp., Trenton, New Jersey
Nitration Cellulose	For cellulose nitrate lacquers and explosives	Rayonier, Inc., New York, New York
Nitrex	Synthetic rubber latex	Naugatuck Chemical Div., U.S. Rubber Co., Naugatuck, Conn.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Nitrex	Synthetic Rubber lattices	Naugatuck Chemical, Div. United States Rubber Co., Naugatuck, Conn.
Nitrocol	Nitrocellulose Base Pigment Dispersion	C. J. Osborn Co., Linden, New Jersey
Non-Fer-Al	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Non-Flam	Plastic Cellulose Derivative, a raw material in sheet form in class 1 raw or partly prepared materials.	Shoe Form Co., Inc., Auburn, New York
Nonic	Non-ionic wetting agent	Pennsylvania Salt Mfg. Co., Industiral Div., Philadelphia, Penna.
Norloc	Handles	Norton Laboratories, Inc., Lockport, New York
Norplex	Laminated Plastics	Northern Plastics Corp., La Crosse, Wis.
Novabestos	Asbestos and/or glass papers and mats for plastic reinforcement and electrical insulation.	Raybestos-Manhattan, Inc., Manheim, Pa.
Nuba	Modified Coumarone-Indene Resin	Neville Chemical Co., Pittsburgh 25, Pa.
Nuplo	All-Products-Hand Tools-Tile, etc.	New Plastic Corp., Los Angeles, Calif.
Nuplaflex	Raw material	New Plastic Corp., Los Angeles, Calif.
Nuplamold	Hand tool line	New Plastic Corp., Los Angeles, Calif.
Nusoil	General mixing varnish	McCloskey Varnish Co., Philadelphia, Penna.
Nylastint	Finely divided nylon molding powders	The Polymer Corp., Reading, Penna.
Nylatint	Nylon dyes	The Polymer Corp., Reading, Penna.
Nylatron	Filled nylons	The Polymer Corp., Reading, Penna.
Nylaweld	Nylon to nylon adhesives	The Polymer Corp., Reading, Penna.
Nyvel	Nylon and film laminate	Velveray Corp., New York, N.Y.
Nylaflow	Nylon pressure tubing	The Polymer Corp., Reading, Penna.

O

Ocenol	Oleyl Alcohol	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Ohmaid	Laminated phenolic plastic equivalent to bakelite, micarta, etc.	Wilmington Fibre Specialty Co., New Castle, Dela-
Ohapex	Specialty plasticizers	Ohio-Apex, Div. F.M.C., Nitro, W. Va.
Oilgear	Fluid Power Equipment	The Oilgear Co., Milwaukee, Wis.
Omya	Calcium carbonate (chalk whiting)	Pluess-Staufer (North American) Inc., New York, New York
Olin	Cellophane, Polyethylene	Olin Mathieson Chemical Corp., Film Division, New York, New York
Opalon	Vinyl chloride molding resin.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Oppanol	Polyisobutylene of various degrees of viscosity	Badische Anilin- & Soda Fabrik A. G., Germany
Orlan	Acrylic Fiber	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Oronite	Solvent, preming solution, thinner, cresylic acids, phenol, phthalic anhydride-ie. (oronite cresylic acid; oronite phenol; oronite phthalic anhydride)	Oronite Chemical Co., San Francisco, Calif.
Oxidex	Anti-oxidant for animal and vegetable fats and oils.	Fritzsche Bros., Inc., New York, New York
Oxy Cold Bar	Static eliminators	Herbert Products, Inc., Woodhaven, New York

P

P. H. I.	Hydraulic presses w/heated platen of steam or electric of tonnage capacities ranging from 20 to 125 ton and platen sizes 8"×8" to 241/2" ×241/2" on our standard line. Also custom designing of presses.	Pasadena Hydraulics, Inc., El Monte, Calif.
PI	Textile Spools	Engineered Plastics, Inc., Gibsonville, North Carolina
PPC	Custom molding	Penn-Plastics Corp., Glenside, Penna.
PT 600	Medium pine tar	Godfrey L. Cabot, Inc., Boston, Mass.
Paladin	Primers for non-ferrous metals and plastics.	Interchemical Corp., Finishes Div., Newark, New Jersey
Palatal	Polyester resins for lacquers and casting	Badische Anilin- & Soda Fabrik A. G., Germany
Palatinol	Softeners for lacquers, plastics, and film-forming materials.	Badische Anilin- & Soda Fabrik A. G., Germany
Panaflex	Hydrocarbon plasticizer	Amoco Chemicals Corp., Chicago, Ill.
Panalon	Resin finish, Resin dispersion	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Panarez	Hydrocarbon resins.	Amoco Chemicals Corp., Chicago, Ill.
Pantasote	Vinyl coated fabric	The Pantasote Co., New York, N.Y.
Pantex	Unsupported vinyl film.	The Pantasote Co., New York, N.Y.
Parasril	Synthetic nitrite type rubber	Naugatuck Chemical, Div. United States Rubber Co., Naugatuck, Conn.
Parasepts	Esters of para-Hydroxy benzoic acid, preservatives.	Heyden Newport Chemical Corp., New York, New York
Paratex	Chlorinated Rubber Paints	Truscon Laboratories, Div. Devoe and Reynolds Co., Inc., Detroit, Mich.
Parcloid	Vinyl resin dispersions	Parcloid Chemical Corp., Midland Park, New Jersey
Paulite	Phosphorescent molding powders and products.	Luminous Resins, Inc., Chicago, Ill.
Pee Vee Cee	Polyvinylchloride sheet	Atlas Mineral Products Co., Mertztown, Pa.
Pellon	Non-woven inner construction material as a lining, interfacing, interlining, or backing for shape renetion purposes.	Pellon Corp., New York, New York
Pent-Acetate	Synthetic Amyl Acetate	Pennsylvania Salt Mfg. Co., Industrial Div., Phila., Penna.
Pentacite	Pentaerythritol Resins.	Reichhold Chemicals, Inc., White Plains, New York
Pentalene 95	Plasticizer extender	Pennsylvania Salt Mfg. Co., Industrial Div., Philadelphia, Penna.
Pentaphen	Para-Tert-Amylphenol	Pennsylvania Salt Mfg. Co., Industrial Div., Phila., Penna.
Pentasol	Synthetic Amyl Alcohol	Pennsylvania Salt Mfg. Co., Industrial Div., Phila., Penna.
Pentek	Pentaerythritol technical	Heyden Newport Chemical Corp., New York, New York
Penton	Linear polyethylene	Hercules Powder Co., Inc., Wilmington, Dela.
Permalux	Neoprene Accelerator	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Permaplast	Chemical resistant molded rubber compositions used for electric storage battery containers.	The Richardson Co., Melrose Park, Ill.
Perma-Skin	Vinyl and epoxy coatings	Dennis Chemical Co., St. Louis, Mo.
Permelite	Reinforced melamine molding compounds	Melamine Plastics, Inc., Winona, Minn.
Permolith	Lithopane	The Sherwin-Williams Co., New York, New York
Petrothene	Polyethylene resin	U. S. Industrial Chemicals Co., Div. National Distillers and Chemical Corp., New York, New York
Phtalopal	Alcohol soluble phthalic resins for nitrocellulose wood lacquers.	Badische Anilin- & Soda Fabrik A. G., Germany
Phenopreg	Phenolic, melamine, polyester, silicone, and epoxy resin impregnated paper, fabric, glass cloth and mat.	Fabricon Products, Div. The Eagle-Pitcher Co., River Rouge, Mich.
Phenoweld	Industrial Adhesive	H. V. Hardman Co., Inc., Belleville, New Jersey
Picco	Coal tar solvents, coating solutions, rubber softener, etc.	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piccocizer	Plasticizer	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piccolastic	Styrene Polymers	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piccolyte	Terpene resins	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piccoumaron	Hydrocarbon resins	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piccopale	Petroleum resins	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Pinto	Composition supported vinyl	The General Tire & Rubber Co., Textileather Div., Toledo, Ohio
Pittsburgh PX	Plasticizers & Epoxy Plasticizers	Pittsburgh Coke & Chemical Co., Pittsburgh, Pa.
Placco	Flat acrylic paint	Customs Coatings Co., Los Angeles, Calif.
Plastilock	Adhesive-structural bonding Agents	The B. F. Goodrich Industrial Products Co., Div. B. F. Goodrich Co., Akron, Ohio
Plastiken	Adhesive-general purpose and cements and putties.	The B. F. Goodrich Industrial Products Co., Div. B. F. Goodrich, Co., Akron, Ohio

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Piccover	Hydrocarbon resins	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Piacquer	Semi-gloss acrylic paint	Custom Coatings Co., Los Angeles, Calif.
Piaspreg	Furane resin impreg. compound.	Furane Plastics, Inc., Los Angeles, Calif.
Plastacele	Cellulose acetate plastic	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Plasticone	Colorants (red)	The Sherwin-Williams Co., New York, New York
Plastigen	Soft resins for lacquers, based on nitrocellulose and other fil formers.	Badische Anilin- & Soda Fabrik A. G., Germany
Plastisand	Phenolic resin coated sand	Acme Resin Corp., Forest Park, Ill.
Plastolein	Plasticizers for vinyls, celluloses and synthetic rubbers.	Emery Industries, Inc., Cincinnati, Ohio
Plastolyn	Vinyl coated fabric	Columbus Coated Fabrics Corp., Columbus, Ohio
Plastomoll	Softeners for lacquers and plastics	Badische Anilin- & Soda Fabrik A. G., Germany
Plastopal	Urea formaldehyde for lacquers, acid-resistant coating, and nitrocellulose lacquers.	Badische Anilin- & Soda Fabrik A. G., Germany
Plastro	Dye for Plastics & Lacquer	Allied Chemical & Dye Corp., National Aniline Div., New York, New York
Plastrong	Re-enforced polyester premixed molding compound.	George Morrell Corp., Muskegon Heights, Mich.
Plo-Tank	Reinforced Polyester for chemical process equipt.	Haveg Industries, Inc., Wilmington. Dela.
Plonco	Phenolic Molding Compounds and Resins.	Plastics Engineering Co., Sheboygan, Wisc.
Pliobond	Rubber base adhesives	The Goodyear Tire and Rubber Co., Akron, Ohio
Pliogrip	"	
Pliotac	"	
Pliolite	Styrene/butadiene rubber reinforcing resins. Styrene butadiene coating resins.	The Goodyear Tire and Rubber Co., Akron, Ohio
Pliolite Latices	Styrene/butadiene copolymer latices	The Coodyear Tire and Rubber Co., Akron, Ohio
Plio-Tuf	Styrene copolymer high impact resins	The Goodyear Tire and Rubber Co., Akron, Ohio
Pliovic	Vinyl chloride polymer and copolymer resins.	The Goodyear Tire and Rubber Co., Akron, Ohio
Pleogen	Polyester resin	American Petrochemical Corp., Mol-Rez Div., Minneapolis, Minn.
Plyacton	Protein adhesives	Reichhold Chemicals, Inc., White Plains, New York
Plyamine	Urea-formaldehyde resins, adhesives, and varnishes.	Reichhold Chemicals, Inc., White Plains, New York
Plyamul	Polyvinyl acetate adhesives	Reichhold Chemicals, Inc., White Plains, New York
Plyophn	Phenol-formaldehyde resins, adhesives and varnishes.	Reichhold Chemicals, Inc., White Plains, New York
Polectron	Vinyl carbazole molding compound; resin polymer	Antara Chemicals, Div. General Aniline & Film Corp., New York, New York
Polesthan	Water-white, polyester embedments	Hanley Plastics Co., St. Louis, Mo.
Pollopas	Carbamide Resin	Dynamit-Actien-Gesellschaft, Troisdorf, Germany
Polyamin P	For waterproof artificial leather and for improving water resistance of paper.	Badische Anilin- & Soda Fabrik A. G., Germany
Polybond	Adhesive and textile finishing and weaving compounds	Polymer Industries, Inc., Springdale, Conn.
Poly-Box Carboy	Polyethylene Carbon in patented wood jacket.	Industrial Plastic Supply, Div. Isaco, Inc., West Hartford, Conn.
Polycast	Cast sheet	The Polycast Corp., Stanford, Conn.
Polyco	Resin emulsions	The Borden Co., Chemical Div., New York, New York
Poly-Eth	Polyethylene Resins	Spencer Chemical Co., Kansas City, Mo.
Polyfilm	Polyethylene film	Extruders, Inc., Hawthorne, Calif.
Polyflex	Film and sheet of plastic composition including oriented polystyrene	Plax Corp., Hartford, Conn.
Poly-Flo	Plastic (pvc) Polyvinyl-Chloride fabrication of precision parts.	Electro-Chemical Products Corp., Cleveland, Ohio
Polyfluoron	Polychlorofluoro Ethylene	Acme Resin Corp., Forest Park, Ill.
Polygard	Stabilizer for use in rubber and plastics.	Naugatuck Chemical, Div. United States Rubber Co., Naugatuck, Conn.
Polygum	Textile printing compounds	Polymer Industries, Inc., Springdale, Conn.
Polyken	Polyethylene film (linear concational), Polyethylene electrical tape, Polyethylene protective tape coatings	The Kendall Co., Polyken Sales Div., Chicago, Ill.
Poly-Kleen	Liquid cleanser	Schwartz Chemical Co., Inc., New York, New York
Poly-Lite	Side and bottom panels for fluorescent lighting fixtures.	Sandee Mfg. Co., Chicago, Ill.
Polylite	Polyester resins	Polyester resins, Reichhold Chemicals, Inc.
Polymerin	Melamine-Alkyd enamel	Interchemical Corp., Finishes Div., Newark, New Jersey
Polymix	Dry blended colored polyethylene	Gering Products, Inc., Kenilworth, New Jersey
Polypenco	Nylon and Teflon molded products.	The Polymer Corp., Reading, Penna.
Polyprene	Vinyl Organosol Enamel	Interchemical Corp., Finishes Div., Newark, New Jersey
Polyrez	Industrial Synthetic resins in the form of Liquids, Solutions, Emulsions, Powders, and Lump.	Polyrez Co., Inc., Woodbury, N.J.
Polytex	Multicolored specks in one application by spraying	Atlas Coatings Corp., Long Island City, New York
Polytreat	Polyethylene film (treated for printing)	Extruders, Inc., Hawthorne, Calif.
Ponsol	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Pontachrome	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Pontacyl	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware
Pontamine	Dyes, Diazo Dyes, Fast Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Por-C-Lyn	Baked enamel finishes of exceptional hardness.	Atlas Coatings Corp., Long Island City, New York
Polytherm	Silicone enamels	Interchemical Corp., Finishes Div., Newark, New Jersey
Pre-Imp	Pre-impregnated chopped rovings	Flexfirm Products, El Monte, Calif.
Pressure-Line	Flexible Polyethylene Pipe with built-in steel, wire mesh, tape or fabric reinforcement	Skyline Industries; Skyline Plastic Pipe, Inc.; Skyline Plastic Molding, Inc., Titusville, Penna.
Propiofan	Plastics dispersion based on acrylic ester	Badische Anilin- & Soda Fabrik A. G., Germany
Protecto-Flex	"Zip-on" vinyl pipe insulation cover.	Miracle Adhesives Corp., Bellmore, New York
Protektinsul	"Zip-on" vinyl pipe insulation cover.	Miracles Adhesives Corp., Bellmore, New York
Protox	Zinc oxides	The New Jersey Zinc Co., New York, New York
Prox-melt	Modified paraffin waxes.	Pyroxylin Products, Inc., Chicago, Ill.
Prox-peel	Strippable coatings	Pyroxylin Products, Inc., Chicago, Ill.
Pyralin	Cellulose Nitrate Plastic	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Pyrocon	Contact pyrometer for surface and other temperature measurement.	Illinois Testing Laboratories, Inc., Chicago, Ill.

Q

QO	Furan Chemicals and Derivatives	The Quaker Oats Co., Chemicals Dept., Chicago, Ill.
Quakerol	Furfural	The Quaker Oats Co., Chemicals Dept., Chicago, Ill.
Quinorgo	Electrical insulations of purified asbestos with organic binder. For use as is or for further treatment.	Johns-Manville, New York, New York
Quinorgobord	Highly purified asbestos base sheet materials for fabrication into electrical insulations.	Johns-Manville, New York, New York
Quinterro	Electrical insulations of 100% purified asbestos base sheet, resin-treated; also same as laminates reinforced with glass cloth or plastic film.	Johns-Manville, New York, New York
Quso	Finely divided amorphous silica.	Philadelphia Quartz Co., Phila., Penna.

R

RC	Natural and synthetic rubber compounds. Plasticizers, plastisols, rigidsols	Rubber Corp. of America, New York, N. Y.
R-Mix-Dek	Non-slip coating floor and deck coating.	Miracle Adhesives Corp., Bellmore, New York
Rx	Sheets of phenolic resin forming paperboard.	Consolidated Paper Co., Monroe, Mich.
Radialloy-tipped	Carbide tipped tools	Radial Cutter Manufacturing Corp., Elizabeth, New Jersey
Remapo	Pigments	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Randoc	Thermosetting resins for impregnating, encapsulating, etc. of electrical and electronic components.	Mitchell Rand Mfg. Corp., New York, New York
Raven	Carbon black	Columbian Carbon Co., New York, New York
Rayacete	For cellulose acetate	Rayonier Inc., New York, New York

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Raybrite	For plastics reinforcement	Rayonier Inc., New York, New York
Raymix	Random cut rayon flock for surface coating.	The Rayon Processing Co. of R. I., Pawtucket, R. I.
Raytallics	Metallic particle for decorative filler in plastics.	The Rayon Processing Co. of R. I., Pawtucket, R. I.
Realite	Decorative high pressure melamine laminates	Reina Associates, Inc., Lowell, Mass.
Reet	Vinyl and polyethylene film and sheeting.	Ross & Roberts Co., Stratford, Conn.
Reevon	Polyethylene filaments and fabrics.	Reeves Brothers, Inc., New York, New York
Refrasil	Silica Fiber Textiles and Batting	H. I. Thompson Fiber Glass Co., Los Angeles
Resimine	Melamine resins, liquid and solid	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Resinite Vinyl Insulation Sleeving	Insulation sleeving and tubing	The Borden Co., Resinite Dept., Santa Barbara, Calif.
Resinite	Thermoplastic synthetic resin wire & cable insulation sleeving	The Borden Co., Chemical Div., New York, New York
Resinox	Phenolic molding resin	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Resloom	Textile finishing resins	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Resmetal	Metallic patching paste, self-hardening solder.	The Borden Co., Chemical Div., New York, New York
Resoform	Colorants	General Dyestuff Co., Div. General Aniline & Film Corp., New York, New York
Resorsabond	Resorcinol Resins	American-Marietta Co., Adhesive, Resin & Chemical Div., Seattle, Wash.
Resproid	Vinyl film sheeting and coated fabric.	The General Tire and Rubber Co., Respro Div., Cranston, Ohio
Reswax	Synthetic wax-resin combination	The Borden Co., Chemical Div., New York, New York
Rexatherm	Baking enamels	Texton Finishes, Inc., Irvington, New Jersey
Rexlacq	Air dry lacquers	Rexton Finishes, Inc., Irvington, New Jersey
Rez-N-Bond	Cement for acrylics and styrene	Schwartz Chemical Co., Inc., New York, New York
Rez-N-Dye	Cold Dip Liquid Dyes	Schwartz Chemical Co., Inc., New York, New York
Rez-N-Glue	All purpose adhesive	Schwartz Chemical Co., Inc., New York, New York
Rez-N-Kleen	Liquid cleaner	Schwartz Chemical Co., Inc., New York, New York
Rez-N-Lac	Lacquers for all plastics.	Schwartz Chemical Co., Inc., New York, New York
Rez-N-Polish	Powder cleaner & anti static	Schwartz Chemical Co., Inc., New York, New York
Richelain	Decorative laminated sheets used for table tops and panels. Furniture drawers molded from plastic materials.	The Richardson Co., Melrose Park, Ill.
Rigidcast	Cast Thermosetting	Heil Process Equipt. Corp., Rigidon Plastic Div., Cleveland, Ohio
Rigidene	Fabricated Polyethylene	Heil Process Equipt. Corp., Rigidon Plastic Div., Cleveland, Ohio
Rigidon	Glass reinforced Polyester	Heil Process Equipt. Corp., Rigidon Plastic Div., Cleveland, Ohio
Rigivin	Rigid vinyl sheet fabrication	Heil Process Equipt. Corp., Rigidon Plastic Div., Cleveland, Ohio
Rincontrol	Wrinkle enamels	Interchemical Corp., Finishes Div., Newark, New Jersey
Rippolite	Structural glass panels made from glass fiber reinforced plastic material.	Rippolite Plastic Products, Inc., Burbank, Calif.
RO-Ball	Gyrating screen sifters	J. H. Day Co., Cincinnati, Ohio
Release	Rubber roll covering for Polyethylene Laminating.	Stowe-Woodward, Inc., Newton Upper Falls, Mass.
Rolox	Adhesives for paint rollers	H. V. Hardman Co., Inc., Belleville, New Jersey
Roracyl	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Rotalin	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Roxoprene	Chlorinated Rubber Enamel	Interchemical Corp., Finishes Div., Newark, New Jersey
Royal Master	Centerless grinding machine	Royal Master, Inc., Riverdale, New Jersey
Rub-Erok	Molded hard rubber x-ray development tanks, tank frames, and tank covers.	The Richardson Co., Melrose Park, Ill.
Rucoam	Vinyl film and sheeting	Rubber Corp. of America, Hicksville, New York
Ruddflex	Elastameric embossed sheeting & film printed, pressed polished and laminated, Poly-vinyl chloride, Poly-vinyl Butyral, Vinyl Formal, Rigid sheeting, Silicones and Elastomeric, Fluocarbons, Fancy Laminates, Styrene Copolymers, Vinyl coated cloth.	Rudd Plastic Fabrics Corp., Brooklyn, New York
Rumaco	Electrical motor driven and belt driven horizontal pumps with or without tanks.	The Ruthman Machinery Co., Cincinnati, Ohio
Ryertex-Omicron PVC	Polyvinylchloride Plastic	Joseph T. Ryerson & Son, Inc., Chicago, Ill.

S

Saflex	Plastic interliner for safety glass.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Safrella	Sassafras odorant	Fritzsche Bros., Inc., New York, New York
Saf-T-Dek	Alkyd Base-Troweled on	Truscon Laboratories, Div. Devoe and Raynolds Co., Inc., Detroit, Mich.
San-D-Lite	Polyethylene sheet materials	Sandee Mfg. Co., Chicago, Ill.
Sandt	Die presses, mechanical and hydraulic. Embossing machines. Perforating machines. Other type equipment.	Atlas-Sandt Corp., New York, New York
Sanitized	Bacteriostat	The Sanitized Sales Co. of America, Inc., New York, New York
Sarcotrol	Mold temperature controller	Sarco Co., Inc., New York, New York
Scriptite	Synthetic resins for use as pigment binding agents.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Sealerine	Concrete sealer	Customs Coatings Co., Los Angeles, Calif.
Sealdbin	Flexible, durable, collapsible container, of multi-ply rubber-coated cord fabric—for shipping of corrosive liquids and dry flowable solids	United States Rubber Co., New York, New York
Sealdtank	Flexible, durable, collapsible container, of multi-ply rubber-coated cord fabric—for shipping and storage of corrosive liquids.	United States Rubber Co., New York, New York
Sealz	Rubberized bitumens	Naugatuck Chemical Div., U. S. Rubber Co., Naugatuck, Conn.
Sea-Deep	Decorative plastics	Hoosier Cardinal Corp., Cardinal Div., Evansville, Indiana
Seilon	P. V. C., Styrene & Polyethylene rolls & sheets for vacuum forming	Seiberling Rubber Co., Plastics Div., Newcomerstown, Ohio
Sevron	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Shaperoll	Collar Stay	Ormond Mfg. Co., Inc., Union City, New Jersey
Shellblast	Soft grit blasting material made of nut shells and used for blast cleaning of molds.	Agrashell, Inc., Los Angeles, Calif.
Sierracin	Cast transparent polyester sheet and monolithic and laminated	The Sierracin Corp., Burbank, Calif.
Sierracote	Transparent conductive coating for heating plastic or glass surfaces.	The Sierracin Corp., Burbank, Calif.
Silastic	Silicone Rubber	Dow Corning Corp., Midland, Mich.
Silcobest	Laminated glass cloth slot wedges	Silicone Insulation, Inc., Bronx, New York
Silvacel	Extender filler and additive (fiber)	Weyerhaeuser Timber Co., Special Prods. Div., Tacoma, Wash.
Silvacon	Extender, filler, and additive (bark)	Weyerhaeuser Timber Co., Special Prods. Div., Tacoma, Wash.
Silvacote	Silver colored vacuum metalized finish.	The Eyelet Specialty Co., Waterbury, Conn.
Silvatrim	Plastic trim	Glass Laboratories, Inc., Brooklyn, New York
Silvaley	Moldable wood fiber	Weyerhaeuser Timber Co., Special Prods. Div., Tacoma, Wash.
Silverlite	Polished, anodized, heavy, sanitary type aluminum. Edging have a silver finish.	Pine-Wood Plastic Co., Inc., Cambridge, Mass.
Sirco Nut Shell Flour	Nut shell flour used as fillers—coconut shell flour, walnut shell flour, pecan shell flour, apricot pit flour, etc.	Bernard Sirotta Co., Brooklyn 31, N. Y.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Sircoblast	Ground Nut Shell Pellets for soft-grit blast-cleaning of metals, molds, and for deflashing of molded plastic products (ground walnut shells, coconut shell, pecan shells, apricot pits, etc.)	Bernard Sirotta Co., Brooklyn, New York
Solfast	Colorants (red and blue)	The Sherwin-Williams Co., New York, New York
Solka-Floc	Finely-divided purified cellulose.	Brown Co., Boston, Mass.
Solox	Denatured Alcohol Solvent	U. S. Industrial Chemicals Co., Div. National Distillers and Chemical Corp., New York, New York
Solozone	Sodium Peroxide	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Solvenon	Dimethyl acetate for solvents and thinner for lackers	Badische Anilin- & Soda Fabrik A. G., Germany
Solvic	Vinyl chloride polymers and vinyl chloride vinyl acetate copolymers	S. A. Solvic, Brussels, Belgium
Spac	Anti-static agent	S. M. Edison Chemical Co., Chicago, Ill.
Span	Emulsifying Agent	Atlas Powder Co., Wilmington, Dela.
Sphinx	Adhesives	Arabol Mfg. Co., New York, New York
Special Acetate Cellulose	For cellulose acetate	Rayonier, Inc., New York, New York
Speedrex	Epoxy resin paints	Truscon Laboratories, Div. Devoe and Raynolds Co., Inc., Detroit, Mich.
Spectro-Chrome	Metallic insert extrusion.	Schwab Plastics Corp., Detroit, Mich.
Span-Amm	Anhydrous Ammonia	Spencer Chemical Co., Kansas City, Mo.
Spansol	Nitrogen solutions	Spencer Chemical Co., Kansas City, Mo.
Spired	Extruding machine with electric heating and high velocity evaporative cooling.	John Royle & Sons, Paterson, N. J.
Spiroyl	Extruding machine with circulating heating and cooling.	John Royle & Sons, Paterson, N. J.
Spraylat	Water base strippable protective coating compounds	Spraylat Corp., New York, New York
Stack-n-Nest	Reinforced polyester tote pan designed to stack and nest within its own dimensions without mechanical aid.	G. B. Lewis Co., Watertown, Wis.
Stalpic	Phenol formaldehyde resin coatings.	A. Gusmer, Inc., Stalpic Div., Woodbridge, New Jersey
Statex	Carbon black	Columbian Carbon Co., New York, New York
Stearite	Hydrogenated stearic acid	Witco Chemical Co., New York, New York
Stixso	Silicate adhesive	Philadelphia Quartz Co., Phila., Penna.
Stenetex	Exterior masonry oil base paint	Truscon Laboratories, Div. Devoe and Raynolds Co., Inc., Detroit, Mich.
S-T-R-E-T-C-H	Polyethylene color concentrate	Gering Products, Inc., Kenilworth, New Jersey
Strip-a-Tube	Multiple Tubes (vinyl)	Jessall Plastics, Inc., Kensington, Conn.
Stycast	A series of casting resins—polyesters, epoxides, etc.	Emerson & Cuming, Inc., Canton, Mass.
Stylplast	Urea-formaldehyde molding compounds	American Viscose Corp., Phila., Penna.
Stymer	Synthetic resins for general use (textiles)	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Styresol	Styrenated Alkyd Resins	Reichhold Chemicals, Inc., White Plains, New York
Stypol	Polyester resin	H. H. Robertson Co., Pittsburgh, Penna.
Styratex	Styrenated Alkyd Resins	Jones-Dabney Co., Louisville, Ky.
Styrex	Copolymer Styrene Acrylonitrile.	Dow Chemical Co., Midland, Mich.
Styrofan	Plastics dispersions for impregnating and coatings.	Badische Anilin- & Soda Fabrik A. G., Germany
Styropor	Foamable polystyrene for the production of porous bodies of any shape	Badische Anilin- & Soda Fabrik A. G., Germany
Styrofoam	Expanded Polystyrene	Dow Chemical Co., Midland, Mich.
Styromix	Dry blended color pre-mixed styrene	Gering Products, Inc., Kenilworth, New Jersey
Styron	Molding Materials	Dow Chemical Co., Midland, Mich.
Sulfanthrene	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Sulfogene	Dyes	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Sullvac	Thermoplastic sheeting rigid and semi-rigid vacuum formable.	O'Sullivan Rubber Corp., Winchester, Va.
Sullvyne	Unsupported vinyl plastic sheeting	O'Sullivan Rubber Corp., Winchester, Va.
Sullvyne-Clad	Unsupported vinyl plastic sheeting laminated to various metals: steel, aluminum, magnesium.	O'Sullivan Rubber Corp., Winchester, Va.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Sunform	Flexible sheet material made of glass fibres impregnated with a thermosetting resin base composition, for use in the fabrication of rigid multiple ply laminated structures.	Electro-Technical Products, Div. San Chemical Corp., Nutley, New Jersey
Superblo	Carbon black	Columbian Carbon Co., New York, New York
Supercarbovar	Medium color channel carbon black	Godfrey L. Cabot, Inc., Boston, Mass.
Super Dylan	Polyethylene (low pressure)	Koppers Co., Inc., Chemical Div., Pittsburgh, Penna.
Superlith	Pure zinc sulphide & concentrated lithopone.	C. J. Osborn Co., Linden, N. J.
Super Multiflex	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Supertone	Urea Formaldehyde Moulding Powder	Lacrinoid Products, Ltd., Essex, England
Surfex	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Suspense	Precipitated Calcium Carbonate	Diamond Alkali Co., Cleveland, Ohio
Swirlustre	Hi-lustre pearlized patterned acrylic sheet	U. S. Plastic Products Corp., Metuchen, New Jersey
Synvaren	Liquid Phenolid Resins	Synvar Corp., Wilmington, Dela.
Sylkyd	Silicone Alkyd Resin	Dow Corning Corp., Midland, Mich.
Syncast	Synthetic resins for casting application	Synco Resins, Inc., Bethel, Conn.
Synco	Phenolic resins	Synco Resins, Inc., Bethel, Conn.
Syncoat	Synthetic resin coatings	Synco Resins, Inc., Bethel, Conn.
Synsize	Urea-formaldehyde resins—Liquid type	Synco Resins, Inc., Bethel, Conn.
Synthane	Laminated plastic products	Synthane Corp., Oaks, Penna.
Syntex	Alkyd Resins	Jones-Dabney Co., Louisville, Ky.
Syntho-Copal	Ester gums and ester gum solutions	Reichhold Chemicals, Inc., White Plains, New York
Syn-U-Tex	Urea-formaldehyde Resins	Jones-Dabney Co., Louisville, Ky.
Synvarite	Powdered urea and phenolic resins	Synvar Corp., Wilmington, Dela.
Synvarol	Liquid Urea Resins	Synvar Corp., Wilmington, Dela.
Supramica	Ceramoplastics	Mycalex Corp. of America, Clifton, New Jersey
Syracawood	Molded decorative accessories	Syracuse Ornamental Co., Inc., Syracuse, New York

T

THFA	Tetrahydrofurfuryl Alcohol	The Quaker Oats Co., Chemicals Dept., Chicago, Ill.
TME	Trimethylolethane	Heyden Chem. Corp., New York 17, N.Y.
TMP	Trimethylolpropane	Heyden Chem. Corp., New York 17, N.Y.
T. S. I.	Teflon rod	Tri-Point Plastics, Inc., Alberson, New York
Tackmaster	Pressure sensitive film adhesive	Rubber and Asbestos Corp., Bloomfield, New Jersey
Tap-Lok (Insert)	Internally & externally threaded bushing	Groov-Pin Corporation, Ridgefield, N. Jersey
Technoscent	Heat resistant plastic odorant	Fritzsche Bros., Inc., New York, New York
Teflon	Tetrafluoroethylene resin & coated glass fabrics, dispersion and molding compounds	E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington 98, Dela.
Tegit	Phenolic-asbestos compound	Garfield Manufacturing Co., Garfield, N.J.
Tenite Acetate	Cellulose acetate-molding composition	Eastman Chemical Products, Inc., Kingsport, Tennessee
Tenite Butyrate	Cellulose acetate butyrate-molding composition	Eastman Chemical Products, Inc., Kingsport, Tenn.
Tenite Polyethylene	Polyethylene molding composition	Eastman Chem. Products, Inc., Kingsport, Tenn.
Tensglex	Latex impregnated paper for labels and misc. printed items.	The Sorg Paper Co., Middletown, Ohio
Tensilite	Laminated Paper Base Plastic	The J. P. Lewis Co., Plastic Products Div., Beaver Falls, N.Y.
Tepidone	Rubber accelerator	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Terasol	30 Polyalkylene ether glycol	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Terek	Cellulose Coated Fabrics	Athol Mfg. Co., New York, New York
Terokon	Cellulose coated paper	Athol Mfg. Co., New York, New York
Teroson	Vinyl coated paper	Athol Mfg. Co., New York, New York
Terpitol	Surface-active agents	Carbide & Carbon Chemicals Co., New York 17, N.Y.
Terson	Vinyl coated fabrics	Athol Mfg. Co., New York, New York.

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Tetrolin	Solvent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Tetrone	Rubber accelerator	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Texol	Plastic artificial leather	Farrington Texol Corp., Walpole, Mass.
Texolex	Plastic coated papers	Farrington Texol Corp., Walpole, Mass.
Textileather	Pyroxylin coated fabric	The General Tire & Rubber Co., Textileather Div., Toledo, Ohio
Textilube	Lubricant used for lubricating bronze bushings used in textile equipment.	National Plastics, Inc., Knoxville, Tenn.
Tex-Trude	Spray nozzles and plastic pipe and fittings.	Texas Plastic Products Co., Houston, Texas.
Thermaband	Cast electric band heaters	Thermel, Inc., Franklin Park, Ill.
Thermacartridge	Electric cartridge heaters	Thermel, Inc., Franklin Park, Ill.
Thermo-fin	Electrical heating of extruders	Davis-Standard Sales Corp., sole selling agts. for The Standard Machinery Co., Mystic, Connecticut
Thermoheater	Cast electric heaters	Thermel, Inc., Franklin Park, Ill.
Thermoplaten	Cast electric platen heaters.	Thermel, Inc., Franklin Park, Ill.
Thermatron	High frequency heat sealing and pre-heating equipment.	Radio Receptor Co., Inc., New York, New York
Thermex	High frequency preheating equipment	The Girdler Co.-Thermex Div., A Div. of National Cylinder Gas Co., Louisville 1, Kentucky
Thermotube	Tubular type electric heaters.	Thermel, Inc., Franklin Park, Ill.
Thermo-Chock	Pipe insulation expanded styrene	Schwab Plastics Corp., Detroit, Mich.
Thermoflex	Rubber antioxidants	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Thermomat	Woven heat panels for industrial puposess	Thermomat Co., Inc., Trenton, New Jersey
Thermoscent	Deodorant for plastics	Fritzsche Brothers, Inc., New York, 11, N.Y.
Thionox	Rubber accelerator	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Thor	Resin emulsions	The Borden Co., Chemical Div., New York, New York
Titanox	White colorants (pigments) for plastics-titanium dioxide as primary pigmenting substance	Titanium Pigment Corp., New York, New York
Toolplastik	Plastic materials for tooling	Rezolin, Inc., Santa Monica, Calif.
Tolex	Fabric supported vinyl	The General Tire and Rubber Co., Textileather Div., Toledo, Ohio
Tolon	Unsupported vinyl sheeting	The General Tire & Rubber Co., Textileather Div., Toledo, Ohio
TorBal	Subminiature toggle switch	The Torsion Balance Co., Clifton, New Jersey
Tourex	Extruded vinyl binding and welting.	Waljohn Plastics, Inc., Brooklyn, New York
Toxilic	Maleic acid and anhydride	National Aniline Div., Allied Chemical & Dye Corp., New York, New York
Transaire	Temperature and pressure transmitters	Taylor Instrument Co., Rochester, New York
Transphalt	Hydrocarbon Polymers	Pennsylvania Industrial Chemical Corp., Clairton, Penna.
Transvair	Pneumatic Conv. System	The Young Machinery Co., Muncy, Penna.
Treadmaster	Retread cement	Rubber and Asbestos Corp., Bloomfield, New Jersey
Trevarno	Phenolic, Polyester, Epoxy, Silicone resin impregnating glass cloth	Coast Mfg. & Supply Co., Livermore, Calif.
Tripentek	Tripentaerythritol technical	Heyden Chem. Corp., New York 17, N.Y.
Trinseal	Teflon sub-miniature terminals	Tri-point plastics, Inc., Albertson, New York
Tri-point	3-color mechanical pencil	Nichol's Product's Co., Moorestown, New Jersey
Trogamid	Polyamide bars	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Trolitan	Stone powder	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Trovidur	Hard PVC blocks, sheets, etc.	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Troytuf	Non-woven fiber reinforcing and surfacing mat.	Troy Blanket Mills, New York, New York
Tuft-Tite	Electronically quilted vinyl sheeting and film.	The Barr Corp., Richmond Hill, New York
Tulfex	Latex Impregnated Label Stock	Archer Label Co., Los Angeles, Calif.
Tungseal	Penetrating Phenolic Sealer	McCloskey Varnish Co., Philadelphia, Penna.
Turbo-Dryer	Dryer-continuous, Desolventizer, Sublimer, Gas reactor	Wyssmont Co., Inc., Long Island City, New York
Turon	Non-woven fabric supported vinyl	The General Tire & Rubber Co., Textileather Div., Toledo, Ohio

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Tween	Emulsifiers	Atlas Powder Co., Wilmington 99, Delaware
Tygobond-30	Adhesive	U. S. Stoneware Co., Akron, Ohio
Tygon	Vinyl-type tubing, paint, etc.	U. S. Stoneware Co., Akron, Ohio
Tygoweld	Adhesive	U. S. Stoneware Co., Akron, Ohio
Tylene	Tooling plastics	Tylene Plastics, Inc., Michigan City, Indiana
Tynex	Nylon bristles, Nylon filaments	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Ty Ply	Rubber &Metal Bonding Agents	Marbon Chem. Div. of Borg-Warner Corp., Gary, Ind.

U

U. S. I. Isosebacic	Mixture of Isomers of Sebacic Acid.	U. S. Industrial Chemicals Co., Div. National Distillers and Chemical Corp., New York, New York
Ubatol	Modified Polystyrene and Acrylic Emulsions.	U B S Chemical Corp., Cambridge, Mass.
Ultramid	Extremely hard, heat resistant plastics, with good surface hardness.	Badische Anilin- & Soda Fabrik A. G., Germany
Ultrapas	Melamine Resin	Dynamit-Actien-Gesellschaft, Troisdorf, W. Germany
Ultron	Vinyl chloride molding resin. Vinyl chloride film and sheets.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Unicel	Blowing agent	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Unifab	Industrial reinforcing fabrics-made from fiber glass.	Ferro Corp., Fiber glass div., Nashville, Tenn.
Uniformat	Chopped strand reinforcing mat- made from fiber glass	Ferro Corp., Fiber Glass Div., Nashville, Tenn.
Union Carbide	Polyethylene, Vinyl, Phenolic and Polystyrene, Plastics Resins and Compounds.	Union Carbide International Co., Div. Union Carbide and Carbon Corp., Plastics Dept. New York, New York
Unirove	Woven roving- made from fiber glass.	Ferro Corp., Fiber glass div., Nashville, Tenn.
Unitite	Hand operated valves.	Hanna Engineering Works, Chicago, Ill.
Unitized	Conveyors	Long Island Equipment Corp., Long Island City, New York.
Unitool	Hydraulic Valves and presses.	Clifton Hydraulic Press Co., Clifton, New Jersey
Unitrol	Hydraulic press	Clifton Hydraulic Press Co., Clifton, New Jersey
Urac	Resin adhesives, urea-formaldehydes	American Cyanamid Co., Plastics & Resins Div., New York, New York
Urecall	Binder for wastewood board and articles molded of such.	Badische Anilin- & Soda Fabrik A. G., Germany
Urefoam	Isocyanate resin expanded foam.	Atlas Mineral Products Co., Mertztown, Penna.
Uvinul	Ultraviolet light absorber; light stabilizer	Antara Chemicals, Div. General Aniline & Film Corp., New York, New York

V

VC-2	Vinyl cement	Schwartz Chemical Co., Inc., New York, New York
Valite	Thermosetting Phenolic Resins derived from Bagasse. Phenolic molding compounds. Phenolic laminating resins. Shell molding resins Phenolic adhesives. Thermoplastic resins used as extenders for vinyl, styreme, ethyl, cellulose, etc.	Valite Corp., New Orleans, La.
Valveseal	Liquid level control storage battery covers.	The Richardson Co., Melrose Park, Ill.
Van-Cor	Plastic pipe and fittings	The Van Dorn Iron Works Co., Cleveland, Ohio
Varlac	An exceptionally high gloss varnish type finish in rapid drying.	Atlas Coatings Corp., L.I.C., New York
Velbac	Napped sheeting and vinyl laminate	Velveray Corp., New York, N.Y.
Velvetex	Film and sheeting laminate	Velveray Corp., New York, N.Y.
Vibrafoam	Cellular Urethane Sheet or Molded Goods.	United States Rubber Co., New York, New York
Vibrin	Polyester resins	Naugatuck Chemical, Div. United States Rubber Co., Naugatuck, Conn.
Vichrome	Vinyl enamels	Interchemical Corp., Finishes Div., Newark, New Jersey
Vicro-Lite	Vinyl coated products for fabrication of movie screens.	L. E. Carpenter & Co., Wharton, New Jersey
Vicrotex	Vinyl coated fabrics	L. E. Carpenter & Co., Wharton, New Jersey
Vinac	Polyvinyl Acetate Emulsion	Colton Chemical Co., Div. Air Reduction Co., Inc., Cleveland, Ohio

TRADE NAME	NATURE OR TYPE OF PRODUCT	COMPANY & ADDRESS
Vinaplas-Lac	Vinyl lacquer	Schwartz Chemical Co., Inc., New York, New York
Vinaquilt	Quilted plastic fabrics	Marbek, Inc., Brooklyn, New York
Vinaflex	Vinyl chloride mixed polymer for film formers used in chemical resistant paints.	Badische Anilin- & Soda Fabrik A. G., Germany
Vinol	Polyvinyl alcohol	Colton Chemical Co., Div. Air Reduction Co., Inc., Cleveland, Ohio
Vin-Se-Lite	Foam Vinyl-ether-open cell structures or unicellular structures.	Foam King, Inc., Bronx, New York
Vinylac	Organic tackifiers	The Borden Co., Chemical Div., New York, New York
Vinylite	Vinyl chloride-acetate coated paper and automobile rear window sheeting, vinyl butyral for auto safety glass.	Union Carbide and Carbon Corp., New York
Vinylite	Vinylite film, sheeting, and vinyl compounds produced by Canadian Resins and Chemicals Limited.	Canadian Resins and Chemicals Limited, Montreal, Quebec, Canada.
Vinylum	Aluminum Powder Dispersions	Argus Chemical Corp., Brooklyn, New York
Viplo	Polyvinyl Chloride Resin and copolymers.	Chemore Corp., New York, New York
Vitron	Glass fibre roving.	L. O. F. Glass Fibers Co., Toledo, Ohio
Vitroplast	Polyester cement	Atlas Mineral Products Co., Mertztown, Penna.
Voplex	Vinyl plastic hose and tube.	Vogt Mfg. Corp., Rochester, N.Y.
Vuepak	Cellulose acetate film	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Vulcalock	Adhesive-rubber to metals and general purpose adhesives.	The B. F. Goodrich Products Co., Div. B. F. Goodrich Co., Akron, Ohio
Vulcan	Oil furnace carbon black.	Godfrey L. Cabot, Inc., Boston, Mass.
Vulcoid	Resin impregnated vulcanized fibre.	Continental-Diamond Corp., Newark, New Jersey
Vygen	Poly (vinyl chloride) Resin	General Tire & Rubber Co., Chemical Div., Akron, Ohio

W

Wallfab	Reinforced plastic flat sheet.	M. C. Gill Corp., El Monte, Calif.
Wallkyd	Alkyd flat wall vehicles	Reichhold Chemicals, Inc., White Plains, New York
Wallpol	Polyvinyl acetate emulsions	Reichhold Chemicals, Inc., White Plains, New York
Wasco Acrylite	Embedded sheets of acrylic plastic	Wasco Products, Inc., Cambridge, Mass.
Wascofilm	Polyethylene moisture barriers in rolls.	Wasco Products, Inc., Cambridge, Mass.
Wascoseal	Plastic sheet vapor barrier.	Wasco Products, Inc., Cambridge, Mass.
Weather-ometer	Testing apparatus, accelerated weathering	Atlas Electric Devices Co., Chicago, Ill.
Weldfast	Thermosetting Cement-Filled epoxy	The Fibercast Corp., Sand Springs, Okla.
Weldox	Adhesives for paint brushes	H. V. Hardman Co., Inc., Belleville, N.J.
Whirlclad	Fused coatings and coating process.	The Polymer Corp., Reading, Penna.
Whirlaint	Coating powders	The Polymer Corp., Reading, Penna.
Wing-Stay	Alkylated phenol antioxidant	The Goodyear Tire and Rubber Co., Akron, Ohio
Witcab	Hydrogenated stearic acid	Witco Chemical Co., New York, New York
Witcoblak	Carbon black	Witco Chemical Co., New York, New York
Witcolith	Carbon black	Witco Chemical Co., New York, New York
Witicizer	Plasticizers	Witco Chemical Co., New York, New York
Wonder Under, The	As backing and/or lamination, padding, cushioning, reinforcing, interfacing medium for all types of vinyl and thermoplastic and thermosetting plastics and rubber.	Pellon Corp., New York, New York
Woodite	Molding material used for molded decorative accessories (syroco and syrocowood).	Syracuse Ornamental Co., Inc., Syracuse, New York
Wyco	Flexible shaft equipment and accessories.	Wyzenbeek and Staff, Inc., Chicago, Ill.
Wilmington Fibre	Vulcanized fibre	Wilmington Fibre Specialty Co., New Castle, Dela.
Wynene	Molded and extruded products.	The National Plastic Products Co., Odenton, Md.
Wynsote	Vinyl Coated Fabric	The Pantasote Co., New York, N.Y.

X

X-1	Plasticizing oil	Neville Chemical Co., Pittsburgh, Penna.
XX	Zinc Oxides	The New Jersey Zinc Co., New York, New York
Xact Ray	Non contact gauges for thickness.	Industrial Gauges, W. Englewood, N.J.
XactRaymatic	Control systems for thickness	Industrial Gauges, W. Englewood, N.J.
Xaloy	Wear resistant ferrous alloy used in bimetallic extruder cylinders.	Industrial Research Laboratories, Div. Honolulu Oil Corp., Los Angeles, Calif.

Z

Zenite	Rubber accelerator	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Zenk	Vinyl coatings	Atlas Mineral Products Co., Mertztown, Penna.
Zyrox	Chloride-containing resins and compounds.	Union Carbide and Carbon Corp., New York
Zytel	Nylon Molding Powder	E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.

ALPHABETICAL LIST OF MANUFACTURERS AND ADDRESSES

A

A & B Plastics, 200 Mercer St., Seattle, 9, Wash.

A & O Plastics Co., 1313 Warren Ave., Downers Grove, Ill.

A & S Steel Rule Die Corp., 195 Chrystie St., New York 2, N.Y.

AAA Plastic Mfg. Co., 308 N. 6th St., St. Louis, Mo.

ABA Tool & Die Co., Inc., 1395 Tolland Tpk., Manchester, Conn.

AGP Corp., 320 W. Main St., Peru, Ind.

A. B. S. Mfg. Co., Inc., 133 W. 19th St., New York, N.Y.

A. S. K. Mfg. Co., 1343 N. Howard St., Philadelphia 22, Pa.

Aacon Industries, Inc., 2303 Coney Island Ave., Brooklyn 23, N.Y.

aaRBee Plastic Co., 4505 W. Jefferson Blvd., Los Angeles 16, Calif.

Aaron Machinery, 45 Crosby, New York, N.Y.

Abaco Industries, 78–21 Queens Blvd., Elmhurst, N.Y.

Abbe Engineering Co., 50 Church St., New York 7, N.Y.

●Abbe, Paul O., Inc., 257 Center Ave., Little Falls, N.J.

Abbott Plastic Machine Corp., 7124 N. Clark St., Chicago 26, Ill.

Able Container Co., 3021 W. 63rd St., Chicago, Ill.

Abco Chemical Co., 2316 Atlantic Ave., Brooklyn 33, N.Y.

Acadia Synthetic Products, 4115 Ogden Ave., Chicago, Ill.

Acco Polymers, 230 W. 41st St., New York 36, N.Y.

Accurate Gold Stamping Co., Inc., 12 W. 17th St., New York 11, N.Y.

Accurate Molding Corp., 35–20 48th Ave., Long Island City 1, N.Y.

Accurate Steel Rule Die Mfg. Co., 22 W. 21st St., New York 10, N.Y.

●Ace Plastic Co., 91–30 Van Wyck Expressway, Jamaica 35, N.Y.

Ace Plastic Molding Corp., 29 E. 19th St., New York 3, N.Y.

Ace Tool & Mfg. Co., 532 Mulberry St., Newark 5, N.J.

Aceto Chemical Co., Inc., 40–40 Lawrence St., Flushing 54, N.Y.

●Acheson Dispersed Pigments Co., 2250 E. Ontario St., Philadelphia 34, Pa.

Acheson Industries, 420 Lexington Ave., New York 17, N.Y.

Achille G. Bureau, Industrial Design 29 W. 57th, N.Y.

Ackerman Plastic Molding Div., Consolidated Iron Steel Mfg. Co., 986 E. 200th St., Cleveland 19, Ohio

●Ackerman-Gould Co., 92–96 Bleecker St., New York 12, N.Y.

Acme Diecutting Mfg. Corp., 43 W. 13th St., New York, N.Y.

Acme Laminating & Plastics Co., Inc., 7207 E. McNichols, Detroit, Mich.

Acme Machinery & Mfg. Co., Inc., 102 Grove St., Worcester 5, Mass.

Acme Plastic Products Co., Inc., 771 Easton Rd., Horsham, Pa.

●Acme Resin Corp., 1401 S. Circle Ave., Forest Park, Ill.

Acme Scientific Co., 1450 W. Randolph, Chicago 7, Ill.

Acor Plasticover Co., Inc., 162 W. 21st St., New York 11, N.Y.

●Acromark Co., The, 5–15 Morrell St., Elizabeth 4, N.J.

Acryvin Corp. of America, 470 E. 99th St., Brooklyn 36, N.Y.

Adams, Kenneth F., 33 Woodycrest Ave., Southbridge, Mass.

Adams Plastic Products, 309 Findlay St., Cincinnati 14, Ohio

●Adamson United Co., 730 Carroll St., Akron 4, Ohio

Adhesive "Plastite" Mastic Co., 114 W. Hubbard St., Chicago 10, Ill.

Adhesive Products Corp., 1660 Boone Ave., New York 60, N.Y.

Adhesive Products, Inc., The, 520 E. Shore Highway, Albany 10, Calif.

Admiral Coated Prods., Inc., 38 Tiffany Place, Bklyn, N.Y.

●Admiral Corp., Molded Products Div., Washington St. & Creamery Rd., W. Chicago, Ill.

Admiral Plastics Corp., 446 12th St., Brooklyn 15, N.Y.

Advance Mfg. Co., 5311 Metropolitan Ave., Brooklyn 37, N.Y.

Advance Molded Plastics Corp., 3124 W. Fillmore St., Chicago 12, Ill.

Advance Molding Corp., 54 W. 21st St., New York 10, N.Y.

●Advance Solvents & Chemical Div. of Carlisle Chemical Works, Inc., 245 5th Ave., New York 16, N.Y.

Aero Plastics Co., 3711 W. Jefferson Blvd., Los Angeles, Calif.

●Aetna Electronics Corp., 207 Stonehinge La., Carle Pl., L.I., N.Y.

●Aetna Engineering Co., Frick Bldg., Pittsburgh 30, Pa.

●Aetna Engineering Co. Div., Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron, Ohio

Aetna Plastic Die Co., 7124 W. Toughy Ave., Chicago, Ill.

Agrashall, Inc., 4560 E. 26th St., Los Angeles 22, Calif.

Air Cruisers Co., Div., The Garrett Corp., P.O. Box 180, Belmar, N.J.

Air Reduction Chemical Co., 150 E. 42nd St., New York 17, N.Y.

Airconductors, 1458 W. Compton Blvd., Compton 3, Calif.

Aircraft Die Cutters, 2801 San Fernando Rd., Los Angeles 65, Calif.

Airmate Co., 1150 Nebraska Ave., Toledo 7, Ohio

Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio

Airoyal Co., The, 1990 Springfield Ave., Maplewood, N.J.

Akromold, Inc., 102 W. Wilbeth Rd., Akron 1, Ohio

●Akron Presform Mold Co., The, 2038 Main St., Cuyahoga Falls, Ohio

Aksjeselskapet Ancas, Prinsensgt. 2, Oslo 6, Norway

Al-Be Industries, 6103 Clara St., Bell Garden, Calif.

Albert, L. & Son, Div. of Bellanca Corp., 21 Nottinghamway, Trenton, N. J.

Alcon Plastics, Inc., 17 Simonds Rd., Fitchburg, Mass.

Aldrich Pump Co., The, Foot of Pine, Allentown, Pa.

Alexander Bernard Co. Inc., 15 Moore St., New York, N.Y.

Alexine Corp., 726 Wiehelm St., Harrison, N.J.

Alframine Corp., 72–76 Putnam St., Patterson 4, N.J.

Algemene Kunstzijde Unie N.V., 25 Flint St., Asheville, N.C.

Alkydol Labs., Inc., 3242 S. 50th Ave., Cicero 50, Ill.

All-Power Mfg. Co., 400 Roosevelt Ave., Montebello, Calif.

All Purpose Roll Leaf Corp., 37 W. Century Rd., Paramus, N.J.

All-Tech Industries, Inc., 1850 N.E. 146th St., Miami, Fla.

Alladin Plastics Inc., 5771 W. 96th St., Los Angeles 45, Calif.

Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

Allegheny Plastics, Inc., Rte. 51 & Thorn Run Rd., Coraopolis, Pa.

Allen, Alva F., Clinton, Mo.

Allen Harlander Co., Inc., 385 Gerard Ave., N.Y.

●Allied Chemical & Dye Corp., The Barrett Div., 40 Rector St., New York 6, N.Y.

●Allied Chemical & Dye Corp., General Chemical Div., 40 Rector St., New York 6, N.Y.

●Allied Chemical & Dye Corp., National Aniline Div., 40 Rector St., New York 6, N.Y.

●Allied Chemical & Dye Corp., Nitrogen Div., 40 Rector St., New York 6, N.Y.

●Allied Chemical & Dye Corp., Semet-Solvay Petrochemical Div., 40 Rector St., New York 6, N.Y.

Allied Engravers, Inc., 552 W. Broadway, New York 12, N.Y.

Allied Engraving & Stamping Co., 17–21 Elm St., Buffalo 3, N.Y.

Allied Mfg. Co., 2200 25th Ave., So. Seattle, Wash.

Allied Plasti-Lite Enterprises, Inc., 2712–18 LaSalle St., St. Louis 4, Mo.

Allied Products Corp., 1267 Burt Rd., Detroit 23, Mich.

Allied Resinous Products, Inc., 525 W. Adams St., Conneaut, Ohio

Allied Resins, Inc., Commerce St., Conneaut, Ohio

● Indicates Advertiser.

Allis, The Louis Co., 427 Stewart St., Milwaukee 7, Wis.
Allis-Chalmers Mfg. Co., 1163 South 70th St., Milwaukee, Wisc.
Alloid Tool & Die Works, Warwick, R.I.
Almac Engineering Co., 110 W. Shaw Pl., Glenshaw, Pa.
Almac Plastics, 600 Broadway, New York 12, N.Y.
Almor Plastics Corp., 79-10 Albion Ave., Elmhurst, L.I., N.Y.
Alpha Chemical & Plastics Corp., 11 Jabez St., Newark 5, N.J.
Alpha Plastics Inc., Okner Pkwy., Livingston, N.J.
Alsteele Engineering Works Inc., 82 Herbert St., Framingham, Mass.
Alsynite Co. of America, 4654 De Soto St., San Diego 9, Calif.
Aluminum Corp. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.
Alpha Chemical & Plastics Corp. 11 Jabez St., Newark 5, N.J.
Alvimar Mfg. Co., Inc., 1881 Park Ave., New York 35, N.Y.
● Ambassador Pls. & Mfg. Corp., 620 N. Michigan, Chicago 11, Ill.
● Ambrogio Truilzi, Via G. Da Proacida #8, Milan, Italy
Amco Plastic Materials, Inc., 96 4th St., Bklyn 31, N.Y.
Amercoat Corp., 4809 Firestone Blvd., S. Gate, Calif.
● American Agile Corp., P.O. Box 168, Bedford, Ohio
American Air Compressor Corp., 48th St. & Dell Ave., N. Bergen, N.J.
American Alkyd Industries, Broad & 14th Sts., Carlstadt, N.J.
American Air Filter Co., Famco, Inc., Div., 6200 Strawberry Lane, Louisville, Ky.
American Blower Corp., 8111 Tireman, Detroit 32, Mich.
American Chain & Cable Co., Inc., Campbell Machine Div., Bridgeport 2, Conn.
American Chain & Cable Co., Inc., Helicoid Gage Div., 929 Connecticut Ave., Bridgeport 2, Conn.
American Collo Corp., 525-535 Oritan Ave., Ridgefield, N.J.
American Combining & Coating Corp., 72-36 Burchell Ave., Arverne 92, N.Y.
● American Cynamid Co., Dyestuff Div., Boundbrook, N.J.
● American Cyanamid Co., Organic Chemicals Div., 30 Rockefeller Plaza, New York 20, N.Y.
● American Cyanamid Co., Pigments Div., 30 Rockefeller Plaza, New York 20, N.Y.
● American Cyanamid Co., Plastics & Resins Div., 30 Rockefeller Plaza, New York 20, N.Y.
American Cystoscope Makers, Inc., 1241 Lafayette Ave., Bronx 59, N.Y.
American Decalcomania Co., 4334 W. 5th Ave., Chicago, Ill.
American Extruded Products Co., 1023 N. LaBrea Ave., N., Hollywood, Calif.
American Gage & Machine Co., Simpson Electric Co., Div., 5200 W. Kinzie St., Chicago 44, Ill.
American Gage & Machine Co., Size Control Co., Div., 2500 W. Washington Blvd., Chicago 12, Ill.
American Hard Rubber Co., 93 Worth St., New York 13, N.Y.
American Hydrotherm Corp., 33-70 12th St., Long Island City 6, N.Y.
● American Insulator Corp., New Freedom, Pa.

● Indicates Advertiser.

American Machine & Metals, Inc., E. Moline, Ill.
American-Marietta Co., 3400 13th Ave., S., Seattle, Wash.
American Metalizing Corp., 150 Bruckner Blvd., New York 54, N.Y.
American Molded Fiberglass Co., 65 Governor St. & Holane St., Peterson, N.J.
American Molding Co., 2000 Davis St., San Leandro, Calif.
● American Molding Powder & Chemical Corp., 703 Bedford Ave., Brooklyn 6, N.Y.
American Monomer Corp., Div. American Resinous Chemicals, 103 Foster St., Peabody, Mass.
American Optical Co., 24 Mechanic St., Southbridge, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
American Plasticraft Co., 2027 Williamsbridge Rd., New York 61, N.Y.
American Plastics Corp., 342 Madison Ave., New York 17, N.Y.
American Polyglas Corp., Broad & 14th Sts., Carlstadt, N.J.
American Polymer Co. of the Chem. Div. of the Borden Co., 103 Foster St., Peabody, Mass.
American Products Mfg. Co., Inc., 8127-33 Oleander St., New Orleans 18, La.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo.
American Pyroxylin Corp., P.O. Box 193 Arlington, N.J.
American Rattan & Reed Mfg. Co., 268 Norman Ave., Brooklyn 22, N.Y.
American Reinforced Plastics Co., 650 S. Spring St., Los Angeles 14, Calif.
American Research & Dev. Corp., The John Hancock Bldg., Boston 16, Mass.
American Resinous Chemicals Corp., 103 Foster St., Peabody, Mass.
American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.
American Standards Testing Bureau, Inc., 44 Trinity Pl., New York 6, N.Y.
● American Steel Foundries, Elmes Engineering Div., 1177 Tennessee Ave., Cincinnati 29, Ohio
● American Steel Foundries, King Machine Tool Div., 1177 Tennessee Ave., Cincinnati 29, Ohio
American Type Founders Co., 200 Elmora Ave., Elizabrth 13, N.J.
American Viscose Corp., 1617 Pennsylvania Blvd., Philadelphia 3, Pa.
American Wheelbrator & Equipment Corp., 837 S. Byrkit St., Mishawaka, Ind.
American-British Chemicals Supply, Inc., 180 Madison Ave., New York 16, N.Y.
American-Marietta Co., Adhesive, Resin, & Chem. Div., 3400 13th Ave., S.W., Seattle 4, Wash.
Ameriplastic Co., The, 3161 Torrey Rd., Flint, Mich.
Amco Plastic Materials, Inc., 80-4th St., Brooklyn 31, N.Y.
Amoco Chemicals Corp., 910 S. Mich. Ave., Chicago, Ill.
● Amos Molded Plastic, Edinburg, Ind.
● Amos Packaging, Edinburg, Ind.
Amphenol Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Amplex Mfg. Co., 2325 Fairmount Ave., Philadelphia 30, Pa.
Amsco Packaging Machinery, Inc., 31-31 48th Ave., Long Island City, N.Y.
● Anchor Plastics Co., Inc., 36-36 36th St., Long Island City 6, N.Y.

Anchorage Plastics Corp., 57 Miller St., Warren, R.I.
Anders Corp., 72 Gray St., Paterson 3, N.J.
Anderson Die & Mfg. Co., 6840 S.W. Macadam St., Portland, Ore.
Andrews, A. M. Company, 4621 Beaverton-Hillsdale Highway, Portland 19, Ore.
Anesite Co., 3575 Touhy Ave., Chicago 45, Ill.
● Angier Products, Inc., 120 Potter St., Cambridge 42, Mass.
Anorgana G.M.B.H., Munchen, Gendorflobb, Germany
● Anson Tools & Gages, Inc., 2733 W. 11th St., Erie, Pa.
● Antara Chemicals, A Sales Div. of General Aniline & Film Corp., 435 Hudson St., New York 14, N.Y.
Apex Electrical Mfg. Co., 1070 E. 152 St., Cleveland 10, Ohio
● Apex Machine Co., 14-12 118th St., College Pt. 56, N.Y.
Apex Reinforced Plastics Div., White Sewing Machine Corp., Elm & Washington Sts., Cleveland 11, Ohio
Applied Engineering Associates, 1952 Flushing Ave., Brooklyn 37, N.Y.
Applied Plastics Co., Inc., 130 Penn St., El Segundo, Calif.
Applied Plastics Div., Keystone Brass Works, Inc., 1102 W. 12th St., Erie, Pa.
● Applied Radiations, 1210 Springdale Rd., Walnut Creek, Calif.
Applied Resins Corp., 304 Oraton St., Newark 4, N.J.
Aquador Plastics Inc., 62-18th St., Brooklyn 32, N.Y.
Arabol Mfg. Co., 110 E. 42nd St., New York 17, N.Y.
● Archer-Daniels-Midland Co., 390 Doremus Ave., Newark, N.J.
● Archer-Daniels-Midland Co., 700 Investors Bldg., Minneapolis, Minn.
● Archer-Daniels Midland Co., 400 Doremus Ave., Newark, N.J.
Archer Label Co., 783 Kohler St., Los Angeles 21, Calif.
Argo Plastic Products, 1095 Brook Park Rd., Cleveland, Ohio
● Argus Chemical Corp., 633 Court St., Brooklyn 31, N.Y.
Argus Plastics, Inc., 411 E. Market St., Indianapolis, Ind.
Aries, R. S., & Assc. 41 East St., N.Y. 45-33 Davies St., Long Island, N.Y.
Aristocrat Plastics, Inc., 23-25 Sussex Ave., Newark, N.J.
Arizona Plastics Co., 1500 E. 36th St., Tucson, Arizona
Armen, Inc., 8-22 Astoria Blvd., Long Island City 2, N.Y.
Armitage, John L. & Co., 245 Thomas St., Newark 5, N.J.
Armored Plastics Co., Div. of Globe-Wernicke Industries, Inc., Lint & Dura Sts., Toledo 12, Ohio
Armstrong, Cecil W. & Associates, P.O. Box 330, Warsaw, Ind.
Armstrong Cork Co., Lancaster, Pa.
Armstrong Machine Works, 932 Maple St., Three Rivers, Mich.
Armstrong Products Co., P.O. Box 1, Warsaw, Ind.
Arnkurt Associate Engineers, 31 E. 27th St., New York 16, N.Y.
Arrow Rubber & Plastic Corp., 493 Boulevard, E., Paterson, N.J.
Art Decorating Co., 4201 Hudson Blvd., N. Bergen, N.J.

Art Plastics Mfg. Co., 1240 S. Main St., Los Angeles 15, Calif.
Artag Engineering Corp., 655 S. Wells St., Chicago 7, Ill.
•Artag Plastics Corp., 2853 W. Irving Pk. Rd., Chicago 18, Ill.
Artmor Plastics Corp., 1003 Oldtown Rd., Cumberland, Md.
Asher & Boertz, Inc., 900 Broadway, New York 3, N.Y.
Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.
Associated Plastic Companies, Inc., 400 E. Hines, Midland, Mich.
Associated Rubber & Plastic Corp., 2780 Park Ave., New York 51, N.Y.
Athol Manufacturing Co., 120 E. 41st St., N.Y.
Atkins & Merrill, Inc., Post Rd., S. Sudbury, Mass.
•Atkins Saw Div., Borg-Warner Corp., 402 S. Illinois St., Indianapolis 2, Ind.
Atkinson Enterprises, 6020 E. Gage St., Bell, Calif.
Atlantic Plastics, Inc., 60 Bonnor St., Stamford, Conn.
•Atlas Coatings Corp., 5–35 47th Ave., Long Island City 1, N.Y.
•Atlas Electric Devices Co., 4114 N. Ravenswood, Chicago 13, Ill.
Atlas Hydraulics, Inc., 3576 Ruth St., Phila. 34, Pa.
Atlas Mineral Products Co., Mertztown, Pa.
Atlas Plastic Specialties, Inc., 3214 W. Lawrence Ave., Chicago 25, Ill.
Atlas Plastics, Inc., 689 Seneca St., Buffalo 20, N.Y.
Atlas Plastics, Inc., 115 Route 46, Little Ferry, N.J.
Atlas Plastic Specialties, Inc., 3214 W. Lawrence Ave., Chicago, Ill.
Atlas Powder Co., Wilmington 99, Del.
Atlas-Sandt Corp., 69 Beekman St., N.Y.
Atlas Vacuum Corp., Rochester, N.Y.
•Atols Tool & Mold Corp., 5005 W. Armitage Ave., Chicago 39, Ill.
•Auburn Plastics, Inc., Canoga St., Auburn, N. Y.
Augusta Plastics Inc., 3820 Boston Post Rd., Bronx 69, N.Y.
Auto-Vac Co., 1984 State St. Ext., Bridgeport, Conn.
Autograf Brush & Plastics Co., Inc., 2320 Sixth Ave., Watervliet, N.Y.
Automatic Methods, Inc., 965 W. Grand St., Elizabeth, N.J.
•Automatic Molding Machine Co., 3217 Exposition Pl., Los Angeles 18, Calif.
Automatic Plastic Molding Co., 830 Bancroft Way, Berkeley 2, Calif.
Avery Adhesive Label Corp., 1616 S. California Ave., Monrovia, Calif.
AVSCO, Inc., 940 Isley Blvd., Excelsior Springs, Mo.
Axel Plastics Research Labs., 1061 Manhattan Ave., Brooklyn, N.Y.
Axelson Mfg. Co., Div. of U.S. Industries, Inc., 6160 S. Boyle Ave., Los Angeles, Calif.
Ayes, Samuel Jr., Assc. 711 Boylston St., Boston 16, Mass.

B

B. B. Chemical Co., 784 Memorial Drive, Cambridge 39, Mass.

•B. I. P. Chemicals Limited, Popes Lane, Oldbury, Nr. Birmingham, England
•B. I. P. Engineering Ltd., Streetly Works, Sutton Coldfield, Warwickshire, England
•B. I. P. Tools Ltd., 127 Tyburn Rd., Birmingham 24, England
B. W. Molded Plastics Co., 1346 E. Walnut St., Pasadena 4, Calif.
B. X. Plastics, Ltd., Higham Station Ave., Chingford, London, England
Babcock & Wilcox Co., 85 Liberty St., New York 6, N.Y.
Bacon & Weber, 1121 N. Ashland Ave., Chicago, Ill.
Bacon, Frederick S. Laboratories, 192 Pleasant St., Watertown 72, Mass.
•Badische Anilin & Soda-Fabrik, Ludwigshafen/RH, Germany
Bahlke, Alfred F., 273 Snyder Ave., Berkeley Heights, N.J.
•Bailey, R. N. & Co., Inc., 11 W. 42nd St., New York 36, N.Y.
•Bakelite Co., Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N.Y.
Baker Bros., Inc., 1000 Post St., Toledo 10, Ohio
Baker Castor Oil Co., The, 40 Avenue A, Boyonne, N.J.
Baker Perkins, Inc., 1000 Hess St., Saginaw, Mich.
Baldwin-Lima-Hamilton, Philadelphia 42, Pa.
Bale Co., 401 Broadway, New York
Ball & Jewell, Inc., 24–28 Franklin St., Brooklyn 22, N.Y.
Balsa Ecuador Lumber Corp., 500 5th Ave., New York 36, N.Y.
Bamberger, A., Corp., 703 Bedford Ave., Brooklyn 6, N.Y.
Bamberger, Claude P., Inc., No. 1 Mt. Vernon St., Ridgefield Park, N.J.
Bangor Plastics, Inc., 809 Washington St., Bangor, Mich.
•Barber-Colman Co., 1300 Rock St., Rockford, Ill.
•Barber-Colman Co., Wheelco Instruments Div., 1300 Rock St., Rockford, Ill.
Barco Mfg. Co., 500–530 N. Hough St. Barrington, Ill.
Barker-Davis Machine Co., Inc., 91 Mechanic St., Leominster, Mass.
Barksdale Valves, 5125 Aloca Ave., Los Angeles 11, Calif.
Barr Corp., 12709 91st Ave., Richmond, N.Y.
Barradas, George, Riverview Court, Glenville, Conn.
•Barrett Div., The Allied Chem. & Dye Corp., 40 Rector St., New York 6, N.Y.
Barrett Varnish Co., 1532 S. 50th St., Cicero 50, Ill.
•Barron, J. E. Plastics, Inc., 807 Sycamore St., Cincinnati 2, Ohio
Barry, B. J. & Co. Inc., 62 Worth St., New York 13, N.Y.
Barry Electronics Corp., 512 Broadway, New York 12, N.Y.
Bart Laboratories, 227 Main St., Belleville, N.J.
Bartrev Ltd., Aries Fibreboard Corp., 400 Madison Ave., New York, N.Y.
Barzantni International Corp., 589 E. Illinois St., Chicago, Ill.
Basic Plastic Materials, Inc., Howard St., Winchester, N.H.
Bassons Industries Corp., 1432 W. Farms Rd., New York 60, N.Y.
Bath, John & Co., Inc., 18 Grafton St., Worcester 8, Mass.
•Battenfeld, Gebr., Teichstr. 12, Meinerzhagen, Western Germany
Bauer, George, Box 531, Keene, N.H.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N.Y.
Baxter Co., The, 2060 Reading Rd., Cincinnati 2, Ohio
•Bay Mfg. Div., Electric Auto-Lite Co., Morton St., Bay City, Mich.
Bay State Tap & Die Co., Mansfield, Mass.
Beach-Russ Co., 50 Church St., New York 7, N.Y.
Beacon Plastic & Metal Products, Inc., 280 Madison Ave., New York 16, N.Y.
Beaman Plastics, 1702 N. E. Sandy Blvd., Portland 14, Ore.
Bean, D. D. & Sons Co., Jaffrey, N.H.
Beardsley & Piper Div., Pettibone Mulliken Corp., 2424 N. Cicero Ave., Chicago 39, Ill.
Beche & van Hullen, Krefeld, Germany
Beck, Charles, Machine Corp., Church Road, King of Prussia, Pa.
Becker & Becker Associates, 300 Park Ave., New York 22, N.Y.
Becker, Moore & Co., Inc., Bridge St., N. Tonawanda, N.Y.
Becker & van Hüllen, Untegath, 100, Krefeld, Germany
Becwar Mfg. Corp., 28 Industrial Rd., Addison, Ill.
Bedford Products, Inc., P.O. Box 36, Roanoke, Va.
Beel Engineering Co., 411 Mulberry St., Newark 2, N.J.
Beetle, Carl N., Plastics Corp., 145 Globe St., Fall River, Mass.
Behr-Manning Corp., 952 Seifert St., Troy, N.Y.
Bel-Art Products, 4917 Murphy Place, West New York, N.J.
•Belding Corticelli Industries, 1407 Broadway, New York 18, N.Y.
Bellows Co., The, 220 W. Market St., Akron 3, Ohio
Beltran Assoc., Inc., 1153 E. 35th St., Bklyn, N.Y.
Bemis Bros. Bag Co., 408 Pine St., Box 93, St. Louis 2, Mo.
Bensing Bros. & Deeney, 3301 Hunting Park Ave., Phila. 29, Pa.
Bentek Co., 1253 Atlantic, B'kln, N.Y.
Ber-Design Associates, 41 Smith St., Irvington, N.J.
Bergen Mold & Engineering Co., 115 Route 46, Little Ferry, N.J.
Bergen Wire Rope Co., 454 Gregg St., Lodi, N.J.
Berglund-Swenson Co., Inc., 554 Elm St., Arlington, N.J.
Berkander, George F., Inc., 891 Broad St., Providence 7, R.I.
Berkeley Engineering & Mfg. Co., 273 Snyder Ave., Berkeley Heights, N.J.
Berkshire Chemicals, Inc., 420 Lexington Ave., N.Y.
Bernard Plastics Molding Corp., 38–40 Tenth St., L.I.C. 5, N.Y.
Berni, Alan & Assoc., Inc., Penthouse, 580 Fifth Ave., N.Y.
Berthelsen Engineering Works, Inc., Lockport Rd., Joliet, Ill.
Berton Plastics, Inc., 586 6th Ave., New York 11, N.Y.
Beryllium Corp., Reading, Pennsylvania
Berzen, Nat F., Inc., 551 5th Ave., New York 17, N.Y.
•Bestwall-Certain-Teed Sales Corp., 120 E. Lancaster, Ardmore, Pa.
Bigelow Fiber Glass Products, Div. Bigelow-Sanford Carpet Co., 140 Madison Ave., New York 16, N.Y.
Bigelow Reinforced Plastics, Homestead Place, Amsterdam, N.Y.

•Indicates Advertiser.

Biggs, Carl H. Co., Inc., 2255 Barry Ave., Los Angeles 64, Calif.
Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N.J.
Binks, Mfg. Co., 3114-40 Carroll Ave., Chicago 12, Ill.
Binney & Smith, Inc., 380 Madison Ave., New York 17, N.Y.
Birckhead Corp., 5205 Fairlawn Ave., Baltimore, Md.
Birdsboro Steel Foundry & Machine Co., 1951 Furnace St., Birdsboro, Pa.
Bischoff Chemical Corp., Main St., Ivoryton, Conn.
Bishop Mfg. Corp., 10 Canfield Rd., Cedar Grove, N.J.
Bjorksten Research Labs., Inc., P.O. Box 265, Madison 3, Wis.
Blacher, B., 752 Broadway, New York 3, N.Y.
● Black-Clawson Co., Dilts Machine Works Div., N. First St., Fulton, N.Y.
Black & Decker Mfg. Co., The, Towson 4, Md.
Black, George Co., 1865 Morris Ave., Union, N.J.
● Blackhawk Molding Co., Inc., Commercial Rd., Addison, Ill.
Blackman Plastics, 5883 Blackwelder St., Culver City, Calif.
Blackwell Plastic Molding Co., Inc., 5606 Cavanaugh, Houston, Texas
Blane Corp., The, 35 Pequit St., Canton, Mass.
Blaw-Knox Co., Chemical Plants Div., 300 Sixth Ave., Pitts. 22, Pa.
Blodgett, G. S. Co., Inc., The, 50 Lakeside Ave., Burlington, Vt.
Bloomfield Molding Co., 147 Bloomfield Ave., Bloomfield, N.J.
Blossom Mfg. Co., Inc., 292 5th Ave., N.Y.C., N.Y.
Blue, E. B. Co., 651 Connecticut Ave., S. Norwalk, Conn.
Blue Ribbon Shoe & Novelty Co., Inc., 76 Crown St., Bklyn, N.Y.C., N.Y.
Bluebird Plastics, Inc., 12th & Orchard Sts., Coshocton, Ohio
Blum, Paul Co., 312-316 Larkin St., Buffalo 10, N.Y.
Blumenthal, Margaret, 10 W. 93rd St. New York 25, N.Y.
Bo Mar Mfg. Co., Inc., 40-42 Washington St., Auburn, N.Y.
Bogan, Stanely, Smoke Rise, Butler, N.J.
Boice-Crane Co., 930 W. Central Ave., Toledo 6, Ohio
● Bolling, Stewart, & Co., Inc., 3190 E. 65th St., Cleveland 27, Ohio
● Bolta Products Inc., Div. General Tire & Rubber Co., 70 Garden St., Lawrence, Mass.
Bond Adhesives Co., 537 Johnson Ave., Brooklyn 37, N.Y.
Bondy Engineering Co., 172 So. Portland Ave., Bklyn, N.Y.
Bonell Plastics, Inc., 4520-22 W. Nr. Ave., Chicago, Ill.
Bonwitt, Dr. G. L. Labs., 17 W. 60th St., New York 23, N.Y.
Bonwitt, Eric, 431 S. Dearborn, Chicago 5, Ill.
● Boonton Molding Co., 326 Myrtle Ave., Boonton, N.J.
Booty Resineers, Inc., 42 S. Third St., Newark, Ohio
● Borco Chemicals, 3105 N. Cicero Ave., Chicago 41, Ill.
Borden Co., The, Chem. Div., 350 Madison Ave., New York 17, N.Y.
Borden Co., Chem. Div., Polyco Dept., 101 Foster St., Peabody, Mass.
● Borg-Warner Corp., Atkins Saw Div., 402 S. Illinois St., Indianpolis 2, Ind.
● Borg-Warner Corp., Marbon Chemical Div., 1926 W. Tenth Ave., Gary, Ind.
● Borg-Warner Corp., Pesco Products Div., 24700 N. Miles Rd., Bedford, Ohio
Borkland Labs., 900 Wabash, Marion, Ind.
Borkland Mfg. Co., Wabash & Quarry Rd., Marion, Ind.
Bortman Plastics Co., 183 Essex St., Boston 11, Mass.
Boruski, Ernest F., Jr., 505 Fifth Ave., New York 17, N.Y.
Boston Research Div., United States Testing Co., Inc., 857 Boylston St., Boston 16, Mass.
Boyden Plastics, Inc., 34 Plastic Ave., Taunton, Mass.
Bradley & Turton, Ltd., Caldwell Works, Kidderminster, England
● Bradley & Vrooman Co., 2629 S. State St., Chicago 16, Ill.
Bramely Machinery Corp., 880 River Rd., Edgewater, N.J.
Brea Chemicals, Inc., 714 W. Olympic Blvd., Los Angeles, Calif.
Breneman-Hartshorn, Inc., 2045 Reading Rd., Cincinnati 2, Ohio
● Brenner, I. G. Co., 32 E. North St., Newark, Ohio
Brewster Ceramic Labs., 1865 Grove St., Glenview, Ill.
Bricmar Manufacturing Corp., 144 Duane Street, N.Y.
Bridgeport Moulded Products Inc., P.O. Box 3276, Barnum Sta., Bridgeport 5, Conn.
Bridgeport Plastics & Rubber Co., 173 Lee Ave., Bridgeport 5, Conn.
Briggs Mfg. Co., 3675 East Outer Drive, Detroit, Mich.
Brilhart Plastics Corp., Old Country Rd., Mineola, N.Y.
Brinks, Plastics, 1646 W. Lake, Chicago 12, Ill.
British Geon Ltd., Devonshire House, Piccadilly, London, S.W. 1, England
● British Industrial Plastics, Ltd., 1 Argyll St., London W. 1, England
British Machine & Foundry Supplies, Ltd., 80 Shore Rd., Port Washington, N.Y.
British Resin Products Ltd., Devonshire House, Piccadilly, London, S.W. 1, England
Brook Molding Corp., 30 Industrial Way Norwalk, Mass.
● Brosites Machine Co., Inc., 50 Church St., New York 7, N.Y.
● Brown Co., 150 Causeway St., Boston 14, Mass.
Brown Machine Co., 110 Pierson, Beverton, Mich.
● Brown-Allen Chemical Co., Box 1, Staten Island 2, N. Y.
Bruce Molded Plastic Products, Inc., 25 Boyd St., Pittsburgh 19, Pa.
● Brunswicke-Balke-Collender Co., 623 S. Wabash Ave., Chicago 5, Ill.
Brush Beryllium Co., The, 4301 Perkins Ave., Cleveland 3, Ohio
Brush Nail Expansion Bolt Co., Greenwich, Conn.
Brutier Products Co., Inc. 165 Peterson Plank Rd., Secaucus, N.J.
Buckeye Cellulose Corp., 2899 Jackson Ave., Memphis 8, Tenn.
Buckeye Molding Co., 213 S. Third St., Miamisburg, Ohio
Buckstaff Co., The, 1122 S. Main, Oshkosh, Wis.
● Budd Co., Inc., Continental-Diamond Fibre Div., Newark 29, Delaware
Budd, John, Eastford, Conn.
Budscraft Inc., 501 Miss. St., Minneapolis, Minn.
Bullock-Smith Associates, 136 Liberty St., New York 6, N.Y.
Burkhardt Co., The, 545 W. Larned St., Detroit 26, Mich.
Burlington Molding Corp., Belmont Rd., Burlington
Burnett, Wm. T. & Co., Inc., Polyurethane Div., 1400 Bush St., Baltimore 30, Md.
● Busada Mfg. Corp., 58-99 54th St., Maspeth 78, N.Y.
● Buss Machine Works, 201 W. 8th St., Holland, Mich.
● Butterfield, T. F., Inc., 56 Rubber Ave., Naugatuck, Conn.
Buttondex Corp., 386 4th Ave., New York 16, N.Y.
● Byrd Plastics, Inc., 2950 W. 12th St., Erie, Pa.

C

C.T.L. Inc., 316 W. 4th St., Cincinnati, Ohio
● Cabot, Godfrey L., Inc., 77 Franklin St., Boston 10, Mass.
Caco Inc., 1193 W. 2nd St., Pomona, Calif.
● Cadet Chemical Corp., Burt, N.Y.
● Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.
Calabro Plastics, 8738 W. Chester Pike, Upper Darby, Pa.
Calcon Mfg. Co., Inc., 100 Oakland Ave., Washington, Pa.
Caldwell Products, Inc., 14 Pelham Pkwy., Pelham Manor 65, N.Y.
California Ink Co., 545 Sansome, San Francisco, Calif.
California Reinforced Plastics, 951 Sixty-First St., Oakland 8, Calif.
Caligari Products, 806-808 W. 21st St., Norfolk, Va.
Callanan, J. A. Co., 118 S. Clinton, Chicago 6, Ill.
Calresin Corp., 4543 Brazil St., Los Angeles 39, Calif.
Calumet Fiberglass Products Co., 5626 Maywood Ave., Hammond, Ind.
● Cambridge Instrument Co., Inc., 3067 Grand Central Terminal, New York 17, N.Y..
Cameron Inc., 4611 N. Clark St., Chicago 40, Ill.
Cameron Machine Co., 61 Poplar St., Brooklyn 1, N.Y.
Camin Laboratories, Inc., 104 S. 4th St., Brooklyn 11, N.Y.
Campbell Machine Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
● Campco Div., Chicago Molded Products Corp., 2717 N. Normandy Ave., Chicago 35, Ill.
Campro Co., The, 3131 Alliance Rd. N. E., Canton, Ohio
Camros Chemical, P. O. Box 482, Newark, N. J.
Canadian General-Tower, Ltd., Middleton St., Galt, Ontario, Canada
Canadian Industries, Ltd., 1253 McGill College St., Montreal, Quebec, Canada
Canadian Resins & Chemicals Ltd., 600 Dorchester St. W., Montreal, Quebec, Canada
Canton Containers, Inc., 1101-9th St., S. E. Canton, Ohio

● Indicates Advertiser.

Cantor, Robert Lloyd, 1450 Jesup Ave., New York 52, N.Y.
Capac Industries, 309 S. Main St., Capac, Mich.
Capitol Plastics Co., 704 Sheridan, Lansing 6, Mich.
• Carbide & Carbon Chemicals Co., Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N.Y.
Carboline Co., 331 Thornton Ave., St. Louis 19, Mo.
Carbon Dispersions, Inc., 27 Haynes Ave., Newark 5, N.J.
Carborundum Co., Niagara Falls, N.Y.
• Cardinal Div., Mimosa Corp., Honea Path Rd., Belton, S. C.
Cargill, Inc., Vegetable Oil Div., Falk Quality Products, P. O. Box 1075, Pittsburgh 30, Pa.
• Carlisle Chemical Works, Inc., West St., Reading 15, Ohio
• Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio
Carmagnola, Ernest D., 26-50 95th St., Jackson Heights, N.Y.
• Carmer Industries, 22 North 26 St., Kenilworth, N.J.
Carnival Toy Mfg., Co., 150 Bruckner Blvd., Bronx 54, N.Y.
Carolina Industrial Plastics Corp., Hay St. Extension, Mt. Airy, N.C.
Carolina Plastics Co., 2801 N. Tyron St., Charlotte 6, N.C.
Carpenter, L. E. & Co., 170 Nr. Main St., Wharton, N. J.
Carpenter Steel Co., The, 137 W. Bern St., Reading, Pa.
Carrier Corp., 300 S. Geddes St., Syracuse 1, N.Y.
• Carroll, J. B. Co., Carroll & Albany, Chicago 12, Ill.
Carter Products Co., Inc., 30 Ionia Ave., S. W., Grand Rapids, Mich.
• Carver, Fred S., Inc., 5 Chatham Rd., Summit, N.J.
Carver-Hill Corp., 9-20 38th Ave., Long Island City 1, N.Y.
Cary Chemical Co., P.O. Box 1128, New Brunswick, N.J.
Cary Chemicals, Inc., 64 Hamilton St., Paterson 1, N.J.
Cary Products Co., 229 W. Avery St., Dallas 6, Texas
• Cast Optics Corp., 125 Newman St., Hackensack 1, N.J.
Castle Plastics, Inc., 141 E. 44st. N.Y.
• Catalin Corp. of America, 1 Park Ave., New York 16, N.Y.
Cee-Jay Extruders, Inc. 29 Denton Ave., New Hyde, N.Y.
• Celanese Corp. of America, Chem. Div., 180 Madison Ave., New York 16, N.Y.
• Celanese Corp. of America, Plastics Div. 290 Ferry St., Newark 5, N.J.
• Celanese Corp. of America, Textile Div., Box No. 1414, Charlotte, N. C.
Celluplastic Corp., 50 Ave. L., Newark 5, N.J.
Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.
Central Screw Co., 3501 S. Shields, Chicago 9, Ill.
Central Solvents & Chemicals Co., 2540 W. Flournoy St., Chicago, Ill.
Central States Roll Leaf Co., 3408 Washington Blvd., St. Louis 3, Mo.
Century Plastics Co., Sawyer Passway, Fitchburg, Mass.
Century Products Co., 14324 Birwood, Detroit 38, Mich.

• Indicates Advertiser.

Chaffe, Ralph & Co., 2358 Market St., San Francisco 14, Calif.
Chambers, S. L. Associates, 11 W. 42nd St., New York 36, N.Y.
Champion Molded Plastics, Inc., 321 N. Portland St., Bryan, Ohio
Champlain Co., 88 Llewellyn Ave., Bloomfield, N.J.
Chanal Plastics Co., 361 Stagg, Brooklyn, N.Y.
Chance, W. R. & Assoc., Inc., 1715 Lee Highway Arlington, Va.
Chaney Plastic Molding Co., 4200 Madison, Denver, Colo.
Chatelain Plastics, 807 S. Blanchard St., Findlay, Ohio
Chelsea Mills, Div. of Novelty, B. B. Co., 350-5th Ave., N.Y.
Chelsea Paper Products Inc., 453 W. 17th St., New York, N.Y.
Chemical Coatings & Engineering Co., 2633 Westchester Pike, Edgemont, Pennsylvania
Chemical Corp., The, 54 Waltham Ave., Springfield 9, Mass.
Chemical Development Corp., Endicott St., Danvers, Mass.
• Chemical & Pigments Co., Div. of The Glidden Co., 1101 Madison Ave., Cleveland, Ohio
Chemical & Power Products, Inc., 11 Broadway, New York 4, N.Y.
Chemical Process Co., 901 Spring St., Redwood City, Calif.
• Chemical Products Corp., King Philip Rd., E. Providence 14, R.I.
Chemical Research Assoc., 7127 Marshall Road Upper Darby, Pa.
Chemiglas, Inc., 4670 De Soto St., San Diego 9, Calif.
• Chemische Werke Hüls Ag., Marl, W. Germ.
Chemold Co., 2000 Colorado Ave., Santa Monica, Calif.
• Chemore Corp., 21 West St., New York 6, N.Y.
Chemtron Fiber Glass Co., 2616 Strozier Ave., El Monte, Calif.
Cheney Bros., 350 5th Ave., New York 1, N.Y.
Cherry, Peter, Elm St., Monroe, Conn.
Cheslam Corp., 684 Nepperhan Ave., Yonkers 2, N.Y.
Chester Packaging Products Corporation, 684 Nepperhan Ave., Yonkers 2, New York
• Chicago Die Mold Div., U. S. Rubber Co., 4001 Wrightwood Ave., Chicago 39, Ill.
• Chicago Mold Engineering Co., Inc., 4141 Washington Blvd., Hillside, Ill.
• Chicago Molded Products Corp., 1020 N. Kolmar Ave., Chicago 51, Ill.
Chicago Price Tag Mfg. Co., 3915 W. Chicago Ave., Chicago 51, Ill.
Chicago Screw Co., 2701 Washington Blvd., Bellwood, Ill.
Chicago Tool & Eng. Co., 8383 S. Chicago Ave., Chicago 17, Ill.
Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago 7, Ill.
Chicksan Co., 330 N. Pomana Ave., Brea, Calif.
Chicopee Mills, Inc., Lumite Div., 40 Worth St., New York 13, N.Y.
Chiksan Co., 330 No. Pomona, Brea, Calif.
Child, S. G. Co., 3249 Cresson St., Philadelphia 29, Pa.
• Chili Plastics, Inc., 2278 W. Side Dr., N. Chili, N.Y.
Chinkes, Sam & Assoc., 72 E. 167th St., Bronx 52, N.Y.
Chippewa Plastics, Inc., 210 E. Columbia, Chippewa Falls, Wis.
Chris Kaye Plastics Mfg. Co., 1200 Madison Ave., Madison, Ill.
• Chromium Corp. of America, 100 Park Ave., New York 17, N.Y.
Church, C. F. Mfg. Co., P.O. Box 471, Holyoke, Mass.
• Ciba Co., Inc., 627 Greenwich St., New York 14, N.Y.
Cincinnati Development & Mfg. Co., 5614 Wooster Pike, Cincinnati 27, Ohio
• Cincinnati Milling Machines, Inc., 4701 Marburg Ave., Cincinnati 9, Ohio
Cincinnati Molding Co., 2037 Florence Ave., Cincinnati 6, Ohio
Cincinnati Testing & Research Labs., 316 W. Fourth St., Cincinnati 2, Ohio
Circle Plastics Co., 502 South Ave., Garwood, N.J.
• Claremont Pigment Dispersion Corp., 407 Flushing Ave., Brooklyn 11, N.Y.
• Claremont Waste Mfg. Co., 169 Main, Claremont, N.H.
Claremould Plastics Co., 200 Wright St., Newark 5, N.J.
Clark Cutler McDermott Co., Fisher St., Franklin, Mass.
Clark Instrument, Inc., 10200 Ford Rd., Dearborn, Mich.
Clark-Aiken Co., The, Water St., Lee, Mass.
Classic Studio, 201 E. 37th St., New York 16, N.Y.
Clearfloat Inc., Mechanic St., Attleboro, Mass.
Clear View Plastics Corp., N. Hillcrest Park, Poplar Bluff, Mo.
Cleveland Process Co., 1967 E. 57th, Cleveland, Ohio
• Clifton Hydraulic Press Co., 289 Alwood Rd., Clifton, N.J.
Clinton Foods, Inc., Clinton, Iowa
Clinton Plastic Molders, 22 Clinton Ave., Brooklyn, N.Y.
Clinwill Plastics, Inc., 701 Seneca, Buffalo 10, N.Y.
Clopay Corp., Clopay Sq., Cincinnati 14, Ohio
Clover Plastic Contours, Inc., 20 Fitch St., E. Norwalk, Conn.
Coaltar Chemicals Corp., 420 Lexington Ave., New York 17, N.Y.
• Coast Mfg. & Supply Co., Box 71, Livermore, Calif.
• Coating Products, 101 W. Forest Ave., Englewood, N.J.
Coe, W. H. Mfg. Co., Inc., 2140 S. Oak Park Ave., Berwyn, Ill.
Cohan Epner Co., Inc., 142 W. 14th St., New York 11, N.Y.
Colburn Laboratories, Inc., 732 S. Federal St., Chicago 5, Ill.
Collier Mfg. Corp., Div., Warren Featherbone Co., Gainesville, Ga.
Collins, Caldwell & Dague, 16616 Garfield Ave., Paramount, Calif.
• Colonial Kolonite Co., 2232 W. Armitage Ave., Chicago 47, Ill.
Colonial Plastics Mfg. Co., The, 2685 E. 79th St., Cleveland 4, Ohio
Colony Import & Export Corp., 11 E. 44th St., New York, N.Y.
Colorite Buttons, 242 W. 38st, N.Y.
Colorite Plastics of N.J., Inc., 35 Iowa Ave., Patterson 3, N.J.
Colors Unlimited, 8685 Melrose Ave., Los Angeles 46, Calif.
Colorvision Plastics, Inc., 182 Beacon St., Boston 16, Mass.
Colt's Plastic Co., Inc., P.O. Box 119 Hartford 15, Conn.

Colton, Arthur Co., 3400 E. Lafayette Ave., Detroit 7, Mich.
Colton Chemical Co., Div., Air Reduction Co., Inc., 1747 Chester Ave., Cleveland 14, Ohio
Columbia Basin Plastics Co., 1900 S. W. Harbor Dr., Portland 1, Ore.
• Columbia Cement Div., Pittsburgh Plate Class Corp., 4327 5th Ave., Pittsburgh, Pa.
• Columbia Div. Lodge & Shipley Co., The, 4th & High Sts., Hamilton, Ohio
Columbia Mills, Inc., 120 W. Onondaga, Syracuse 1, N.Y.
Columbia Pulverizing Corp., Shiller St., Elizabeth, N.J.
Columbia-Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
• Columbian Carbon Co., 380 Madison Ave., New York 17, N.Y.
• Columbian Carbon Co., Magnetic Pigment Div., 601 Cass St., Trenton 10, N.J.
Columbian Rope Co., 309 Genesee St., Auburn, N.Y.
Columbus Coated Fabrics Corp., Seventh & Grant Avenues, Columbus 16, Ohio
Columbus Moulded Products Corp., 856 E. Main St., Columbus 5, Ohio
Columbus Plastic Products, Inc., 1625 W. Mound St., Columbus 23, Ohio
Colvin-Friedman Co., 697 Morris Turnpike, Springfield, N.J.
Comerio Ercole S.p.a., Via S. Pellico, 3, Busto Arsizio, Italy
• Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.
Comet Novelty Co., 30 First St., Adams, Mass.
Comey Plastics, 3940 Easton Ave., St. Louis 13, Mo.
Commander Mfg. Co., 4225 W. Kinzie St., Chicago 24, Ill.
• Commercial Plastics Co., 2812 W. North Ave., Chicago 47, Ill.
• Commercial Plastics & Supply Corp., 630 Broadway, New York 12, N.Y.
Commercial Solvents Corp., 17 E. 42nd St., New York 17, N.Y.
Commonwealth Plastics Corp., 98 Adams St., Leominster, Mass.
Commonwealth Pipe & Tubing, Inc., 125 S. 2nd St., Phila., Pa.
• Como Plastics, Inc., 1703 Keller Ave., Columbus, Ind.
Compo Chemical Co., Branch St., Mansfield, Mass.
Composition Materials Co., Inc., 25 W. 43rd St., New York 36, N.Y.
• Conforming Matrix Corp., 12th & Woodruff Sts., Factories Bldg., Toledo 2, Ohio
Conley, Ed, Plastic Corp., 321 S. Quincy, Tulsa, Okla.
Conn-Craft Co., 301 Fairlawn Ave., Waterbury 4, Conn.
Conneaut Rubber & Plastics Co., Commerce St., P.O. Box 257, Conneaut, Ohio
• Connecticut Plastic Products Co., Inc., 70 W. Liberty St., Waterbury 20, Conn.
Conolite Div., Continental Can Co., 205 W. 14th St., Wilmington, Del.
Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Consolidated Electrodynamics, Rochester Div., 1775 Mt. Read Boulevard, Rochester, N.Y.
Consolidated Engineering Corp., N. Sierra Madre Villa, Pasadena 15, Calif.

• Indicates Advertiser.

Consolidated Iron-Steel Mfg. Co., Ackerman Plastic Molding Div., 986 E. 200th St., Cleveland 19, Ohio
• Consolidated Molded Products Corp., 309 Cherry St., Scranton 2, Pa.
Consolidated Paper Co., 1521 E. First, Monroe, Mich.
Consolidated Plastic Sales Co., 7806-08 Gravois Ave., St. Louis 23, Mo.
Consolidated Plastics & Mfg. Co., 413 W. Chicago Ave., Chicago 10, Ill.
Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 13, N.Y.
Consoweld Corp., 700 Hooker St., Wisconsin Rapids, Wis.
Continental Can Co., Fibre Drum Div., 995 S. Glenn St., Van Wert, Ohio
Continental Can Co., Millsplastic Div., 135 S. La Salle St., Chicago 3, Ill.
Continental Can Co., Shellmar Betnar Div., Mt. Vernon, Ohio
• Continental-Diamond Fibre Div. of The Budd Co., Inc., Newark 29, Del.
Continental Machinery Co., Inc., 261 Broadway, New York 7, N.Y.
Continental Oil Co., 1300 Main St., Houston, Texas
Continental Oil Co., Petrochemical Dept., 1270 Ave. of the Americas, N.Y.C. 20, N.Y.
Continental Plastics Corp., 2934 W. Lake St., Chicago 12, Ill.
Continental Plastics Corp., 519 N. California, Oklahoma City, Okla.
• Contour Extrusion Co., 519 Fayette Ave., Mamaroneck, N.Y.
Convoy, Inc., 3424 Navarre Rd. S. W., Canton 6, Ohio
• Cook, Lawrence H., Inc., 65 Massasoit Ave., E. Providence 14, R.I.
Cooke Color & Chemical Co., Rt. S-24, Hackettstown, N.J.
Copolymer Corp., 2250 E. 111th St., Los Anegles 59, Calif.
• Cordo Chemical Corp., 34 Smith St., Norwalk, Conn.
• Cordo Molding Products Inc., 230 Park Ave., New York 17, N.Y.
Corn Products Sales Co., 17 Battery Pl., New York 4, N.Y.
Cornell Paperboard Products Co., 1514 E. Thomas Ave., Milwaukee 1, Wis.
Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio
• Cosmos Electronic Machine Co., 656 Broadway N.Y. 12, N.Y.
• Cosom Engineering Corp., 6012 Wayzata Blvd., Mpls., Minn.
Cotton, C. B. & Co., 114 Forrest St., Brooklyn 6, N.Y.
• Covema, S.R.L., Via Fontana No. 5, Milan, Italy
Covey, Laird, Monroe Tnpk., Monroe, Conn.
Cowan Boyden Corp., 50 Aleppo St., Providence 9, R.I.
Cox Plastics Corp., 162 Colgate Ave., Buffalo 20, N.Y.
Crane Packing Co., 6400 Oakton St., Morton Grove, Ill.
Cranston Molding Co., 16 Manhasset St., Cranston 10, R.I.
Cratex Mfg. Co., 81 Natoma St., San Francisco 5, Calif.
Creative Plastics Corp., N. Country Rd., Stony Brook, N.Y.
Crellin Plastics Corp., 87 Center St., Chatham, N.Y.
• Crescent Plastics, Inc., 955 Diamond Ave., Evansville, Ind.
Crest Chemical Industries, 72 Delavan St., Brooklyn 31, N.Y.
Crest Molded Products, Inc., 401 Kieways Ave., Arcadia, Calif.
Criterion Decalcomania Co., Inc., 7 E. 42nd St., New York 17, N.Y.
Crompton-Richmond, 1071 6th Ave., New York, N.Y.
Crook, Wm. A. Co., 36 Pleasant St., Watertown, Mass.
Cropp Engineering Div., Warren Plastics Corp., Warren, Pa.
Crowl, Charles Co., 11667 McBean Drive, El Monte, Calif.
Crown Eng. & Sales Co., 421 Hill St., Harrison, N.J.
Crown Flock Co., Inc., Minster, Ohio
Crown Machine & Tool Co., 2800 W. Lancaster Blvd., Ft. Worth 7, Texas
Crown Machinery, Inc., 2721 San Pedro St., Los Angeles 11, Calif.
Crown Tool, Inc., R.I.-2005 N. Wabash St. Wabash, Ind.
Crown Zellerbach Corp., Gaylord Container Corp. Div., 111 N. 4th St., St. Louis 2, Mo.
Crownoil Chemical Co., 2-14 49th Ave., Long Island City 1, N.Y.
Crucible Steel Co. of America, P.O. Box 88, Oliver Bldg., Pitts., 22, Pa.
Cruver Mfg. Co., 2460 W. Jackson, Chicago 12, Ill.
Crystalx Corp., West Lenni Rd., Lenni Mills, Pa.
Cryton Precision Products, 1473 Barnum Ave., Bridgeport 8, Conn.
• Cumberland Engineering Co., Inc., P.O. Box 216, Providence 1, R.I.
Cuming, M. A. & Co., Inc., 49 Bleecker St., New York 12, N.Y.
Curbell, Inc., 777 Hertel Ave., Buffalo 7, N.Y.
Curd Enterprises, Inc., Multiplastics Div., 3337 Lincoln St., Franklin Park, Ill.
Currie & Van Dyck, High Meadow Rd., Southport, Conn.
Curry Arts Laminating Co., 522 Green Ridge St., Scranton 9, Pa.
• Curtis Machine, Jamestown, N.Y.
• Curtiss-Wright Corp., Plastics Div., Quehanna, Pa.
Cushing & Nevell, 101 Park Ave., Rahway, N.J.
Custom Coatings Co., 10819 Venice Blvd., Los Angeles 34, Calif.
• Custom Engineering Co., 2414 McKinley Ave., Erie, Pa.
• Custom Machine & Design, Inc., 200 S. Forge, P.O. Box 1064, Akron, Ohio
Custom Scientific Instruments, Inc. 541 Devon St., Kearny, N.J.
Cutler-Hammer, Inc., Development Dept., 315 N. 12th St., Milwaukee, Wis.
• Cylinder Mfg. Co., 2 Maitland Ave., Hawthorne, N.J.

D

D & G Plastics Co., Tallmadge Rd., Kent, Ohio
• D & R Plastic Welders, Inc., P.O. Box J. Hazardville, Conn.
Da-Lyte Awning Co., 638 Sibley St., Hammond, Ind.
• Dake Corp., 633 Monroe St., Grand Haven, Mich.
Damac Tool Co., 456 E. 166th St., Bronx 56, N.Y.
Damen Tool & Eng. Co., 2300 N. Elston Ave., Chicago 14, Ill.
Danberg Chemical Co., Box 124, Wallingford, Conn.
• Daniels, T. H. & J. Ltd., Stroud, Glos., England
Daniels-Kummer Engraving Co., 1200 N. 31th Ave., Melrose Park, Ill.

• Danielson Mfg. Co., The, Danielson, Conn.
Dapol Plastics, Inc., 90 Grove St., Worcester 5, Mass.
Darnell Manufacturing Co., 156 Madison Rd., Orange, Va.
Darling & Co., 4201 S. Ashland Ave., Chicago, Ill.
Darr, Harold W. Associates, 5 E. 22nd St., Minneapolis 4, Minn.
• Davidson-Kennedy Co., 1090 Jefferson Ave., Atlanta, Ga.
• Davies, Harry, Molding Co., 1428 N. Wells St., Chicago 10, Ill.
Davies, Helen & Associates, 140 W. 57th St., New York 19, N.Y.
• Davis, Joseph, Plastics Co., 450 Schuyler Ave., Arlington, N.J.
Davis Mills Corp., United Merchants Industrial Fabrics Div., 1407 Broadway, New York 18, N.Y.
• Davis-Standard Sales Corp., 12 Water St., Mystic, Conn.
Dawbarn Brothers, Inc., Waynesboro, Va.
Dawson, F. C. Engineering Co., Rr. 641 Washington St., Canton, Mass.
Day, J. H. Co., Inc., Div. of Cleveland Automatic Mach. Co., 4932 Beech St., Norwood, Ohio
Dayton Plastics, Inc., 1934 Stanley Ave., Dayton 3, Ohio
Dayton Rogers Mfg. Co., 2824 13th Ave., S., Minneapolis 7, Minn.
• De Mattia Machine & Tool Co., Chelsea Rd., Clifton, N.J.
De Sanno, A. P. & Son, Inc., Wheatland St., Phoenixville, Pa.
Deakin, J. Arthur & Son, 150-28 Hillside Ave., Jamaica 32, N.Y.
Dean Products, Inc., 1042 Dean St., Brooklyn 38, N.Y.
DeBell & Richardson, Inc., Water St., Hazardville, Conn.
Debo, L. F. Mfg. Co., 5969 Transit Rd., Depew, N.Y.
Dec-Art Process Co., Inc., 349 Canal Place, Bronx 51, N.Y.
• Decar Plastic Corp., 1322 University Ave., Middleton, Wis.
Decatur Plastic & Eng., Inc., 407 Holly, Decatur, Ala.
Decotone Products Div., Fitchburh Paper Co., 193 Kimball St., Fitchburg, Mass.
• Deecy Products Co., 120 Potter St., Cambridge 42, Mass.
Deerfield Plastics Co., Inc., 271 Main St., S. Deerfield, Mass.
Dekoron Products Div., Moore, Samuel & Co., Main & Orchard, Mantua, Ohio
Del Incorporated 401 Cleveland Ave., Columbus 13, Ohio
Delaware Valley Plastics Co., 5641 Ogantz Ave., Philadelphia 41, Pa.
Delft Co., 20 E. Jackson, Chicago 4, Ill.
Delkay Plastics Corp., 238 No. Freeman Blvd. Inglewood 3, Calif.
Delta Products, 1400 Henderson St., Fort Worth, Texas
Deluxe Saw & Tool Co., 500 E. Main St. Louisville, 2, Ky.
Dennis Chemical Co., 2701 Papin St., St. Louis 3, Mo.
Denver Plastics, Inc., 15200 W. Colfax, Golden, Colo.
Dependable Compressor & Machine Co., 157 W. 21st. St., New York 11, N.Y.
Derlein Plastics, Cascade, Wis.
• Desert Sunshine Exposure Tests, 7740 Ramona Rd., Phoenix, Arizona
Design Dynamics, Inc., 221 N. La Salle St., Chicago, Ill.
Design Research Inc., 420 N. Michigan Ave., Chicago 11, Ill.
Deskey, Donald Assoc., 630 Fifth Ave., N.Y. 20, N.Y.
Desimone, A. J. Corp., 485 Boulevard, E. Paterson, N.J.
Despatch Oven Co., 619 S. E. 8th St., Minneapolis 14, Minn.
Detecto Scales, Inc., 540 Park Ave., Bkyn. 5, N.Y.
• Detroit Macoid Corp., 12340 Cloverdale Ave., Detroit 4, Mich.
• Detroit Mold Engineering Co., 6686 E. McNichols Rd., Detroit 12, Mich.
• Detroit Stamping Co., 350 Midland Ave., Detroit, Mich.
• DeVilbiss Co., The, 300 Phillips Ave., Toledo 1, Ohio
Devco Engineering Inc. P.O. Box 387, Caldwell, N.J.
Devoe & Reynolds Co., Inc., Truscon Labs. Div., 1700 Caniff St., Detroit 11, Mich.
Dewes-Gumbs & Heath Die Co., 403-5 Broome St., New York 13, N.Y.
• Dewey & Almy Chemical Co., Div. W. R. Grace & Co., 62 Whittemore Ave., Cambridge 40, Mass.
Dexter, C. H. & Sons., Inc., 4 Canal Bank, Windsor Locks, Conn.
• Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio
Diamond Hard Chromium Co., 44 Wall St., Newark 5, N.J.
Diamond Tool Research Co., Inc., 380 Second Ave., New York 10, N.Y.
Dice, J. W., 16 Highwood Ave., Englewood, N.J.
Dickten & Masch Mfg. Co., 900 E. Vienna Ave., Milwaukee 12, Wis.
Diehl, G. Mateer Co., Lincoln Highway, Strafford, Pa.
Dielect Inc., Cedar & Gross Sts., Fords, N.J.
Dielectric Materials Co., 5315 N. Ravenswood Ave., Chicago 40, Ill.
• Diemolding Corp., 125 Rasbach St., Canastota, N.Y.
Dilley Mfg. Co., 1655 Doan Ave., Cleveland, Ohio
Dillon, W. C. & Co., Inc., 14620 Keswick St., Van Nuys, Calif.
• Dillon-Beck Mfg. Co., 1227 Central Ave., Hillside, N.J.
• Dilts Machine Works, Fulton, N.Y.
Dimco-Gray Co., 207 E. 6th, Dayton 2, Ohio
Disston, Henry & Sons, Inc., Unruh & Milnor Sts., Phila. 35, Pa.
Distinctive Embedments, Inc., 42 Guno St., Providence 6, R.I.
Divine Bros. Co., 200 Seward Ave., Utica 1, N.Y.
Dixon Corp., Bristol, R.I.
DoAll Co., The, 254 N. Laurel Ave., Des Plaines, Ill.
Doggett, Stanley, Inc., 99 Hudson St., N.Y.
Dolphin Paint & Varnish Co., Champlain & Locust Sts., Toledo 3, Ohio
Doram Products Inc., 906 Lincoln Blvd., Middlesex, N.J.
Dornbusch & Co., Kalanderstr, 19/25, Krefeld 22A, Germany
Dorrie Process Co., 60 Greenpoint Ave., N.Y. 10, N.Y.
Double A Products Co., Manchester, Mich.
• Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.
• Doven Mach. & Eng. Inc., 2706 Van Buren St., Chicago 12, Ill.
Dover Molded Products Co., 1000 East Ave., Dover, Ohio
• Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Box 592, Midland, Mich.
Dowding & Doll Ltd., 346 Kensington High St., London, England
Doxam Products, Inc., Box 3, Middlesex, N.J.
• Drakenfeld, B. F. & Co., Inc., 45 Park Pl., New York 7, N.Y.
Dravo Corp., Neville Island, Pittsburgh 25, Pa.
Drew, E. F. & Co., 15 E. 26th St., New York 10, N.Y.
Dreyfus, L. A. Co., P.O. Box 500, So. Plainfield, N.J.
Drying Systems, Inc., 1800 Foster Ave., Chicago 40, Ill.
Du Bois Plastic Products, Inc., 168/170 Florida St., Buffalo 8, N.Y.
• du Pont de Nemours, E. I. & Co., Inc., Wilmington 98, Del.
Du Verre, Inc., 374 Delaware Ave., Buffalo, N.Y.
Duke Plastics Corp., 584 Broadway, B'klyn, 17, N.Y.
Dunay Co., 381 4th Ave., New York, N.Y.
• Dunning & Boschert Press Co., Inc., 329 W. Water St., Syracuse 2, N.Y.
Duofold Inc., Canal St. Mohawk, N.Y.
Duplicon Co., Inc., Turnpike Rd., Westboro, Mass.
Dura Flex Co., 2043 Colorado Ave., Santa Monica, Calif.
Dura Plastics of New York, 303 Fifth Ave., N.Y. 16, N.Y.
Dura-Lee Corp., 908 Broadway, Kansas City 5, Mo.
Durra, J. B. & Co., 77 Washington St., Chicago, Ill.
Durable Formed Products, Inc., 6 Greene St., New York 13, N.Y.
Durable Plastics Co., Inc., 814 6th Ave. S., Seattle 4, Wash.
Duralastic Products Co., 2075 W. Lafayette, Detroit 16, Mich.
Durant Mfg. Co., 1925 N. Buffam St., Milwaukee 1, Wis.
Durethene Corp., 1859 S. 55th Ave., Chicago 50, Ill.
• Durez Plastics & Chemicals, Inc., 888 Walck Rd., N. Tonawanda, N.Y.
• Dusenbery, John Co., Inc., 271 Grove Ave., Verona, N.J.
Dyform Corp., 202 E. Cherry St., New Castle, Pa.
Dynakon Fibreglass Corp., 9603 Clinton Road, Cleveland 9, Ohio
• Dynamit-Actien, Gesellschoft 272, Troisdorf, Germany

E

• Eagle Tool & Machine Co., Evans Terminal Rd., Hillside, N.J.
• Eagle-Picher Co., Fabricon Products Div., 1721 W. Pleasant Ave., River Rouge 18, Mich.
• Eagle-Picher Co., American Bldg., Cincinnati 8, Ohio
Eagle Plastic Corp. 23-10 Bridge Plaza Co., L.I.C., N.Y.
Eagle Signal Corp. 202-20th St., Moline, Illinois
• Eagle Tool & Machine Co., Evans Terminal Rd., Hillside, N.Y.
Eastern Moulded Products Co., The, 7 Madison St., S. Norwalk, Conn.
• Eastman Chemical Products, Inc., Kingsport, Tenn.
• Eastman Chemical Products, Inc., 260 Madison Ave., New York 16, N.Y.

• Indicates Advertiser.

● Eastman Kodak Co., Cellulose Products Div., 343 State St., Rochester 4, N.Y.
Eastman Machine Co., 779 Washington St., Buffalo 3, N.Y.
Easton, Wm. H. Jr., Fairfax, Wilmington, Del.
Eby, Hugh H., Co., 4700 Stenton Ave,. Phila. 44, Pa.
Eclipse Fuel Engineering Co.. 1100 Buchannan St., Rockford, Ill.
Eclipse Mfg. Co., 48 So. Old Rand Rd. Lake Zurich, Ill.
Edison, S. M., Co., 2710 So. Parkway, Chicago, Ill.
Edgar Bros. Co., Plastic Kaolin Co., Metuchen, N.J.
● Egan, Frank W. & Co., 115 Lincoln Blvd., Bound Brook, N.J.
Ehrman, Ernst, 61 E. 66th St., New York 21, N.Y.
Eiler Equipment Co., 1170 S. 2nd St., Minneapolis 15, Minn.
Einson-Freeman, Starr & Borden Ave., L.I.C., N.Y.
El Dorado Div., Foremost Food & Chem. Co., P.O. Box 599, Oakland, Calif.
Elastomer Chemical Corp., 212 Wright St., Newark 5, N.J.
Elcone Metallizing Co., 160 5th Ave., New York 10, N.Y.
● Electric Auto-Lite Co., Instrument & Gauge Div., 1201 Champlain St., Toledo 1, Ohio
● Electric Auto-Lite Co., Bay Mfg. Div., Morton St., Bay City, Mich.
Electro-Chemical Products Corp., 16190 Saranac Rd., Cleveland 10, Ohio
Electro Development Co., 14701 Keswick St., Van Nuys, Calif.
● Electro-Devices, Inc., Servospeed Div., 4-6 Godwin Ave., Paterson 1, N.J.
Electro-Mechano Co., 261 E. Erie Pl., Milwaukee 2, Wis.
Electro Plastic Fabrics Inc., 64 1st., St. Pulaski, Va.
Electro-Steel Products, Inc., 112-114 N. 7th St., Phila., Pa.
Electro-Tech Equipment Co., 308 Canal St., New York 13, N.Y.
● Electro-Technical Products Div., Sun Chemical Corp., 113 E. Centre St., Nutley 10, N.J.
● Electrochemical Div. of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Electrochemical Industries, Inc., 35 Armory St., Worcester 3, Mass.
Electroformex Labs., 863 Washington St., Canton, Mass.
● Electromold Corp., 140 Enterprise Ave., Trenton 9, N.J.
Electronic Mechanics, Inc., 101 Clifton Blvd., Clifton, N.J.
Electronic Processes Corp. of Calif., 2190 Folsom St., San Francisco 10, Calfi.
Electronic Wave Products Inc., 15 East 22nd St., New York 10, N.Y.
Eldon Manufacturing Co., 1010 East 62nd st. L.A., Calif.
● Electronics Div., Curtiss-Wright, 631 Central, Carlstadt, N.J.
Elgood Materials Corp., 372-80 Ten Eyck St., Brooklyn 6, N.Y.
Elkloid Co., The, 756 Eddy St., Providence 3, R.I.
Ellay Rubber Co., 1312 E. 12th St., Los Angeles 21, Calif.
Ellen Products Co., 15 Maple Ave., Haverstraw, N.Y.
Ellies, Dave, 395 E. Broad St., Columbus 15, Ohio
Elliot Plastics, Inc., 218 N. St. Clair St., Dayton 2, Ohio
Elm Coated Fabrics Co., Inc., 261 5th Ave., N.Y.C. 16, N.Y.
● Elmes Engineering Div., American Steel Foundries, 1153 Tennessee Ave., Cincinnati 29, Ohio
Elton, Ted, 84 Lawrence Drive, N. White Plains, N.Y.
Elyria Molding & Engineering Co., 317 Prospect St., Elyria, Ohio
● Emeloid Co., Inc., The, 1239 Central Ave., Hillside 5, N.J.
Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.
Emerson Plastics Corp., Seabury Ave. & Butler Place, Bronx 61, N.Y.
● Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio
Emet Plastics Corp., 3500 Park Ave., N.Y.
Emet Vacuum Forming Corp., 426 Union Ave., B'klyn. 11, N.Y.
Empire Brushes, Inc., 200 William St., Port Chester, N.Y.
Emsig Mfg. Co., 225 W. 60th St., New York 23, N.Y.
● Endura Corp., Quakerstown, Pennsylvania
Enduro Tool & Engineering Co., 4134 W. Chicago Ave., Chicago 51, Ill.
Energized Materials Corp., 30 N. LaSalle St., Chicago 2, Ill.
● Engelking Patterns, Inc., 1537 Hutchins Ave., Columbus, Ind.
Engineered Nylon Products, 1318 S. Olive Rd., South Bend, Ind.
Engineered Plastics, Inc., 122-128 W. 10th St., Baxter Springs, Kansas
Engineered Plastics, Inc., Chase St., Gibsonville, N.C.
Engineered Products, Inc., 215 S. Taylor Ave., Kirkwood, St. Louis 22, Mo.
Engineering Laboratories, Inc., Colfax Ave., Pompton Lakes, N.J.
Engineering Plastics Co., 45 E. Walnut St., Pasadena 1, Calif.
Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.
● English Mica Co., The, 79 Prospect, Stamford, Conn.
● Enjay Co., Inc., 15 W. 51st St., New York 19, N.Y.
● Entoleter Div., Safety Industries, Inc., 1187 Dixwell Ave., Hamden 26, Conn.
Entwhistle, James T. Co., 1475 Elmwood Ave., Providence 7, R.I.
Epoxylite Corp., The, 10829 E. Lentral Ave., El Monte, Calif.
Equitable Paper Bag Co., Inc., 40-50 Van Dan St., L.I.C. 1, N.Y.
● Erdco Engineering Corp., Westgate & Official Sts., Addison, Ill.
● Erie Engine & Mfg. Co., 953 E. 12th St., Erie, Pa.
● Erie Foundry Co., 1253 W. 12th St., Erie 6, Pa.
● Erie Plastics Co., Div. of Erie Iron & Supply Corp., 1059 Buffalo Rd., Erie, Pa.
● Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Erinoid Ltd., Lightpill Mills, Stroud., Gloucestershire, England
Ernst, John Enterprises, 201 S. Shore Dr., Rt. 1, East Troy, Wis.
● Escambia Bay Chemical Corp., 70 Memorial Drive, Cambridge, Mass.
Esselen Research Div., United States Testing Co., 857 Boylston St., Boston 16, Mass.
Esso Standard Oil Co., 15 W. 51st St., New York 19, N.Y.
Evans Research & Development Corp., 250 E. 43rd St., New York 17, N.Y.
Evans-Winter-Hebb, Inc., 818 W. Hancock Ave., Detroit 1, Mich.
Evans-Zeier Plastic Co., Route 1, Madison 4, Wis.
Ever Ready Label Corp., 357 Cortlandt St., Belleville 9, N.J.
Eveready Plastics, 151 Merritts Ave., N.E., Atlanta, Ga.
Eveready Pressurized Products, Inc., 1101 Bolt Line St., Cleveland 9, Ohio
Everest Machine & Tool Co., Inc., Westwood, N.J.
Everett Pulp & Paper Co., Everett, Wash.
Everlite, Inc., 2040-15th Ave., W., Seattle 99, Wash.
Exact Weight Scale Co., The, 919 W. 5th Ave., Columbus 8, Ohio
Excel Plastic Mfg. Corp., 458 W. 168th St., New York 32, N.Y.
● Exeter Mfg. Co., 40 Worth St., New York 13, N.Y.
● Explosives Div. of E. I. duPont de Nemours & Co. Inc., Wilmington, Del.
Extruded Plastics, Inc., New Canaan Ave., Norwalk, Conn.
Extruders, Inc., 3232 W. El Segundo Blvd., Hawthorne, Calif.
Extrudofilm Corp., 36-35 36th St., L.I.C., N.Y.
Eyelet Specialty Co., 50 State, Waterbury 20, Conn.

F

F.I.M.S.A.I. Ltd., Stephenson, 120/14, Milano, Italy
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Sanvito Silvestro 103, Varese-Masnago, Italy
Fabra-Seal Corp., 1170 Broadway, New York 1, N.Y.
Fabri-Form Co., The, 258 W. Main St., Byesville, Ohio
Fabri-Kal Corp., 242 E. Kalamazoo Ave., Kalamazoo, Mich.
● Fabrico Mfg. Corp., 1714 W. Division St., Chicago 22, Ill.
● Fabricon Products Div., Eagle-Picher Co., 1721 W. Pleasant Ave., River Rouge 18, Mich.
Fabrite Metals Corp., 1547 Covert St., Brooklyn, N.Y.
● Faeco Machine Co., Inc., 229 Preakness Ave., Paterson, N.J.
Fairchild Guided Missiles Div., Fairchild Engine & Airplane Corp., Straight Path, Wyandanch, N.Y.
Fairfield Plastic Inc., Kenwood Ave., Fairfield, Conn.
Fairfield, Robert E., 327 Canton St., Stoughton, Mass.
Falcon Equipment Co., 13th St., New Brighton, Pa.
Falge Engineering Corp., 4733 Elm St., Bethesda 14, Md.
Falk & Co., P.O. Box 1075, Pittsburgh 30, Pa.
Falk Glass & Plastic Co., Inc., 48-10 Astoria Blvd., L.I.C. 3, N.Y.
Falk Quality Products, Cargill, Inc., P.O. Box 1075, Pittsburgh 30, Pa.
● Falls Engineering & Mach. Co., 1734 Front St., Cuyahoga Falls, Ohio
Falls Hollow Staybolt Co., 7 E. Portage Cuyahoga Falls, Ohio
Famco Inc., Div., American Air Filter Co., 6200 Strawberry Lane, Louisville, Ky.
Farbwerke Hoechest AG. vormals Meister Lubigs & Bruning, FFm., Hoechest, Germany

---

● Indicates Advertiser.

Farley & Loetscher Mfg. Co., 7th & White St., Dubuque, Iowa

●Farrel-Birmingham Co., Inc., Ansonia, Conn.

Farrington Texol Corp., 2000 Main St., Walpole, Mass.

Fawn Plastics Co., Inc., 2900 Hamilton Ave., Baltimore 14, Md.

Federal Adhesives Corp., 210 Wythe Ave., B'klyn 11, N.Y.

Federal Chemicals Corp., 210 Wythe Ave., B'klyn 11, N.Y.

Federal Container Corp., 4300 Olson Hwy. Minn. 22, Minn.

Federal Industries, 681 Main St., Belleville 9, N.J.

Federal Latex Corp., 210 Wythe Ave., B'klyn 11, N.Y.

Federal Mold & Engineering Corp., 32 Water St., Clinton, Mass.

●Federal Tool Corp., 3600 W. Pratt Blvd., Chicago 45, Ill.

Federico, Joseph B., 789 W. Ferry, Buffalo 22, N.Y.

●Fellows Gear Shaper Co., The, 78 River St., Springfield, Vt.

Felsenthal, G. & Sons, Inc., 3500 Kedzie Ave., Chicago 18, Ill.

Fenco Mfg. Co., 2685 Mogadore Rd., Akron 5, Ohio

Fenwal Inc., Pleasant St., Ashland, Massachusetts

Fer Ploxchemicals, Inc., 500 5th Ave., N.Y. 36, N.Y.

Ferriot Bros., Inc., 2685 Mogadore Rd., Akron 5, Ohio

●Ferro Chemical Corp., 450 Krick Rd., Bedford, Ohio

●Ferro Corp., 4150 E. 56th St., Cleveland 5, Ohio

●Ferro Corp., Fiber Glass Div., 200 Woodycrest Ave., Nashville, Tenn.

●Ferro Enamel Corp., 4150 E. 56th St., Cleveland 5, Ohio

Ferro-co Corp., Schori Process Div., 8–11 43rd Rd., Long Island City 1, N.Y.

●Fiber Glass Div., L.O.F. Glass Fibres Co., Nicholas Bldg., Toledo, Ohio

●Fiber Glass Div., Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.

Fiber Glass Plastic Inc., 4725 E. 10th Ave., Hialeah, Fla.

Fiber Glass Plastics Corp., 52 Davenport, Stamford, Conn.

●FiberiSpecialty Mfg. Co. Div., National Vulcanized Fiber Co., 1718 Girard Trust Bldg., Phila. 2, Pa.

Fibercast Corp., The, 100 S. Lincoln, Sand Springs, Okla.

Fiberesin Plastics Co., P.O. Box 429 Oconomowoc, Wis.

●Fiberfil, Inc., Fox Farm Rd., Warsaw, Ind.

●Fiberite Corp., 516 W. Fourth St., Winona, Minn.

Fiberite Corp., 80 E. Jackson Blvd., Chicago, Ill.

Fiberoid Doll Products Corp., 605 E. 132nd St., New York 54, N.Y.

Fibre Drum Div., Continental Can Co., 995 S. Glenn St., Van Wert, Ohio

Filo Color & Chemical Corp., 202 E. 44th St., New York 17, N.Y.

Filon Plastics Corp., 2051 E. Maple Ave., El Segundo, Calif.

Filtron Co., Inc., Flushing 55, N.Y.

●Fine Organics, Inc., 211 E. 19th St., New York 28, N.Y.

●Finish Engineering Co., Inc., 1115 Cherry St., Erie, Pa.

●Fiore, William M., Inc., 135 Liberty St., New York 6, N.Y.

Firestone Industrial Products, Akron, Ohio

●Firestone Plastics Co., P.O. Box 690, Pottstown, Pa.

Firestone Tire & Rubber Co., Loxite Sales Div., Xylos Rubber Co., Akron 1, Ohio

Firth, F. George, 3221 Barry Ave., Los Angeles, Calif.

Fischer, Andrew J., Assoc., 4554 Broadway, Chicago 40, Ill.

Fischer & Porter Co., 30 Warminster Rd., Hatboro, Pa.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 10, Pa.

Fishman Plastics Co., Inc., 442 W. Garfield Blvd., Chicago 9, Ill.

Fitchburg Paper Co., Decotone Products Div., 193 Kimball St., Fitchburg, Mass.

Fjellman American, Inc., 105 Republic Ave., or P.O. Box 1205, Joliet, Ill.

Flambeau Plastics Corp., 501 Seventh St., Baraboo, Wis.

Flexaust Co., The, 100 Park Ave., New York 17, N.Y.

Flexcraft Industries, 527 Ave. P & Wilson, Newark 5, N.J.

Flexfirm Products, 2300 N. Chico Ave., El Monte, Calif.

Flexible Products Co., 312 Dobbs St., Marietta, Ga.

Flexifoam Embossing Corp., 427 E. 146th St., New York 55, N.Y.

Flexifoam Products Mfg. Co., Inc., 545 Fifth Ave., New York 17, N.Y.

Flexiglass Mfg. Corp., N.J. Route 23, Pompton Plains, N.J.

Flexigrip Inc., 504 E. 74th St., New York, N.Y.

Flexrock Co., 3609 Filburt St., Philadelphia, Pa.

Flick-Reedy Corp., Melrose Park, Ill.

●Flightex Fabrics Inc., 93 Worth St., New York 13, N.Y.

Flintkote Co., The, 30 Rockefeller Plaza, New York 20, N.Y.

Floatex, Inc., Berlin Turnpike, Berlin, Conn.

Flodins Industri AB, Lysekil, Sweden

Florian, Gordon, 97 Argonne St., Bridgeport 4, Conn.

Foam King, Inc., 1816 Boston Rd., Bronx 60, N.Y.

Foam Products Co., Marblehead, Mass.

Foiltone Products, Inc., 70 Memorial Drive, Cambridge 42, Mass.

Food Machinery & Chemical Corp., Westvaco Chlor-Alkali Div., 161 E. 42nd St., New York 17, N.Y.

Food Machinery & Chemical Corp., Westvaco Mineral Products Div., 161 E. 42nd St., New York 17, N.Y.

Forbes Products Corp., 625 S. Goodman, Rochester 20, N.Y.

Foredom Electric Co., 27 Park Pl., New York 7, N.Y.

Foremost Food & Chemical Co., El Dorado Div., P.O. Box 599, Oakland 4, Calif.

Foremost Machine Builders, Inc., 52 Vanderbilt Ave., New York 17, N.Y.

Forest Fiber Products Co., Box 68, Grove, Ore.

Form-A-Lite, Inc., Providence Rd., Northbridge, Mass.

Formica Co., The, 4614 Spring Grove Ave., Cincinnati 32, Ohio

●Formvac Corp., Div. of Welding Engineers, Inc., 601 W. 26th St., New York 1, N.Y.

●Forrest Mfg. Co., Inc., 231 State Hgwy. 17, Rutherford, N.J.

Fortney Mfg. Co., Inc., 247 New Jersey Railroad Ave., Newark 5, N.J.

●Foster & Allen, Inc., 628 South Ave., Garwood, N.J.

●Foster Grant Co., Inc., Petrochemical Div., 289 Main, N., Leominster, Mass.

Foster-Whitney, Inc., 1175 E. 156th St., New York 59, N.Y.

●Fostoria Pressed Steel Corp., N. Main St., Fostoria, Ohio

Foxboro Co., Neponset St., Foxboro, Mass.

France, Campbell & Darling, Inc., Michigan Ave., Kenilworth, N.J.

Francis Cushing Hall, 2019 Briarwood Rd., Charlotte 7, N.C.

Francis Industries, 25 E. Depot St., Pataskala, Ohio

Frank, J. P. & Co., Inc., 11 E. 26th St., New York 67, N.Y.

Frank Plastics Corp., 2941 E. Warren St., Detroit 7, Mich.

Franklin Fibre-Lamitex Corp., 411 E. Front St., Wilmington 99, Del.

Franklin Mineral Products Co., Inc., Franklin, N.C.

Franklin Plastics Inc., Div., Franklin, Pa.

●French Oil Mill Machinery Co., 1035 Greene St., Piqua, Ohio

Fried Novelties, 5215 New Utrecht Ave., B'klyn 19, N.Y.

Fritzsche Bros., Inc., 76 Ninth Ave., York 11, N.Y.

Froehling & Robertson, Inc., 814 W. Cary, Richmond 6, Va.

Frohlick & Co., Inc., 34 E. 51st St., New York, N.Y.

Fruehauf Trailer Co., Strick Trailers Div., Spruce St., Perkasie, Pa.

Fuchs, Ernest Co., 76–32 Park Lane South, Woodhaven 21, N.Y.

Fukal, A. F., 3754 Tangley Rd., Houston 5, Texas

Fuller, H. B. Co., 255 Eagle St., St. Paul 2, Minn.

Fullerton Mfg. Co., 343 E. Santa Fe, Fullerton, Calif.

●Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif.

G

G. & T. Mfg. Co., Inc., 326 South St., New Britain, Conn.

●G.M.C. Process Corp., 718 Broadway, New York 12, N.Y.

Gabriel Mfg. Co., Maple & Fairmount Ave., Haverstraw, N.Y.

Gair, Robert Co., Inc., 155 E. 44th St., New York 17, N.Y.

●Gane Bros & Lane, Inc., 1335 W. Lake St., Chicago 7, Ill.

Garan Chemical Corp., 210 E. Olive St., Gardena, Calif.

Garfield Mfg. Co., 10 Midland Ave., Garfield, N.J.

Garlock Packing Co., 402 Main St., Palmyra, N.Y.

Garray Plastics Co., Inc., 333 Bergen Ave., Kearny, N.J.

Garrett Corp., The, Air Cruisers Div., P.O. Box 180, Belmar, N.J.

Garrison Co., The, 214 Front St., S. Plainfield, N.J.

Garvan, P. Inc., 236 Hamilton St., Hartford 6, Conn.

●Indicates Advertiser.

Gary Enterprises, Inc., 249–49th St., B'klyn 20, N.Y.
Gaylord Container Corp., Div. of Crown Zellerbach Corp., 111 North 4th St., St. Louis, 2, Mo.
Gaylord Plastics, 2121 S. Sepulveda Blvd., Los Angeles 25, Calif.
Gaylord Plastics, Inc., 1643 19th St., Santa Monica, Calif.
Gaynes Engineering Co., 1642–52 W. Fulton St., Chicago 12, Ill.
Geauga Industries Co. Inc., S. Main St., Middlefield, Ohio
● Geissel Mfg. Co., Inc., 109 Long Ave., Hillside 5, N.J.
Gemloid Corp., 78–01 Queens Blvd., Elmhurst 73, N.Y.
● General American Transportation Corp., 135 S. LaSalle St., Chicago 90, Ill.
● General American Transportation Corp., Parker-Kalon Div., Clifton, N.J.
● General Aniline & Film Corp., Commercial Development Dep't., 435 Hudson St., New York 14, N.Y.
General Color Co., 24 Ave. B, Newark 5, N.J.
● General Die Mold Co., 548 N. Sacramento Blvd., Chicago 12, Ill.
General Dispersion Inc., 165 Third Ave., Paterson, N.J.
● General Dyestuff Co., Div., General Aniline & Film Corp., 435 Hudson St., New York, N.Y.
● General Dyestuff Corp., Antara Chemicals Div., 435 Hudson St., New York 14, N.Y.
General Dynamics Corp., Electro Dynamics Div., 445 Park Ave., New York, N.Y.
● General Electric Co., Apparatus Dept., Schenectady, N.Y.
● General Electric Co., Chemical & Metallurgical Div., 1 Plastics Ave., Pittsfield, Mass.
● General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Engineering Co., (Radcliffe LTD.) Station Works, Bury Road, Lancaster, Lancashire, England
General Fibre Co., 1723 Locust St., St. Louis 3, Mo.
General Fibre Co., Inc., South St., Walpole, Mass.
● General Industries Co., The, Taylor & Olive Sts., Elyria, Ohio
General Machine & Tool Works, Inc., 40261–13 Mile Rd., Walled Lake, Mich.
General Machine Co. of N.J., 55 Evergreen Ave., Newark 5, N.J.
General Mills, Inc., Chemical Div., So., Kensington Road, Kankakee, Ill.
General Mills Research Labs., 2010 E. Hennepin Ave., Minneapolis 13, Minn.
General Molded Products Inc., 1365 Lee St., Des Plaines, Ill.
General Molds & Plastics Corp., 1435–37 Western Ave., Pittsburgh 33, Pa.
● General Plastics Corp., 1400 N. Washington, Marion, Ind.
General Plastics Corp., Generalfiber, Inc., 2260 Centinela Ave., Los Angeles 64, Calif.
General Plastics Corp., 165 Third Ave., Paterson 4, N.J.
General Plastics Mfg. Co., 3481 S. 35th St., Tacoma 9, Wash.
General Research & Supply Co., 572 S. Division Ave., Grand Rapids 3, Mich.

● Indicates Advertiser.

● General Roll Leaf Mfg. Co., 85–03 57th Ave., Elmhurst, L.I., 73, N.Y.
● General Tire & Rubber Co., Belta Pdts. Div., 70 Garden St., Lawrence, Mass.
● General Tire & Rubber Co., The, Chemical Div., 1708 Englewood Ave., Akron 9, Ohio
● General Tire & Rubber Co., The, Industrial Products Div., Garfield, Wabash, Ind.
● General Tire & Rubber Co., Plastics Div., 1708 Englewood Ave., Akron 9, Ohio
● General Tire & Rubber Co., Textileather Corp., Div., 607 Madison Ave., Toledo 3, Ohio
Genesee Laboratory, Inc., 16 Garden St., Auburn, N.Y.
Georgia Kaolin Co., 433 N. Broad St., Elizabeth, N.J.
Ger-Ell Mfg. Co., 2446 Indiana Ave., Chicago 16, Ill.
Gerin Mfg. Co., Inc., 683 N. Fifth St., Newark 7, N.J.
● Gering Products Inc., N. 7th St., & Monroe Ave., Kenilworth, N.J.
Gershon Irvin J., 1877 Springfield Ave., Maplewood, N.J.
Gessner Mfg. Co., 241 N. Main, Ambler, Pa.
Gesswein, Paul H. Co., Inc., 35 Maiden Lane, New York 38, N.Y.
Gibbs Automatic Molding Corp., 1106 Fifth St., Henderson, Ky.
Gibbs Mfg., 725 Channing Way, Berkeley, 10, Calif.
Gibson Associates, 390 North Ave., Cranford, N.J.
Giddings & Lewis Machine Tool Co., 142 Doty St., Fond du Lac, Wis.
Gilbert, The Wm. L. Clock Corp., 276 N. Main St., Winsted, Conn.
Gill, M. C. Corp., 1422 Potrero, El Monte, Calif.
● Gilman Bros. Co., The, Gilman, Conn.
Gilman, Marty Inc., Gilman, Conn.
Girdler Co., The, Div. of National Cylinder Gas Co., Thermox Div., P.O. Box 987, Louisville 1, Ky.
Girdler Co., Votator Div., Div. of Nat'l. Cylinder Gas Co., 224 E. Broadway, Louisville 1, Ky.
Gits Molding Corp., 4600 W. Huron St., Chicago 44, Ill.
Gladwin Plastics, Inc., 165 Courtland St. N.E., Atlanta, Ga.
Glascraft Co., 1607 E. 21st St., Jacksonville, Fla.
Glaskyd, Inc., Eckel Road, Perrysburg, Ohio
Glasply Corp., 70 Lyons Pl., Mount Vernon, N.Y.
Glass Fibers, Inc., 1810 Madison Ave., Toledo 2, Ohio
Glass, Harry H., Bros., 10 Van Courtland Ave. E. N.Y.
Glass Laboratories, Inc., 863–65th St., B'klyn 20, N.Y.
● Glass Yarns & Deeside Fabrics Ltd., 121 Kingsway, London, W.C. 2, England
Glassoloid Corp. of America, 32 Wellington Ave., Clifton, N.J.
Glastic Corp., The, 4321 Glenridge Rd., Cleveland 21, Ohio
Glastrusion Inc., 1335 Santiago Ave., Santa Ana, Calif.
Gleich, Emanuel D., 145 Spring St., York 12, N.Y.
Glengarry Equipment Corp., Box 85, Bay Shore, N.Y.
● Glenn Electric Heater Corp., 254 Canal St., New York 13, N.Y.

Glidden Coating Co., Commercial Ave., Pitman, N.J.
● Glidden Co., The, 1326 Union Commerce Bldg., Cleveland 2, Ohio
Globe Imperial Corp., 2025 Kishwaukee St., Rockford, Ill.
Globe Molded Plastics Co., N. 6th & Washington Ave., Byesville, Ohio
Globe-Wernecke Industries, Inc., Div., Armored Plastics Co., Inc., Lint & Dura Sts., Toledo 12, Ohio
Glyco Products Co., Inc., Empire State Bldg., New York, N.Y.
Goldman, Neal Associates, Inc., 34 E. 51st St., New York 17, N.Y.
Gomar Mfg. Co., Inc., 1501 Blanche, Linden, N.J.
Goodall-Sanford, Inc., Off Ash St., Reading, Mass.
Goodrun Products Corp., 263 William St., Englewood, N.J.
● Goodrich, B. F. Co., Adhesives Div., 60 Cherry St., Akron 8, Ohio
● Goodrich, B. F., Industrial Products Co., 5000 So. Main St., Akron, Ohio
● Goodrich, B. F. Chemical Co., 324 Rose Bldg., Cleveland 15, Ohio
● Goodrich, B. F. Co., Plastics Div., Westview, Marietta, Ohio
Goodrich-Gulf Chemical Co., 4317 Chester Ave., Cleveland, Ohio
● Goodyear Tire & Rubber Co., Inc., 1144 E. Market St., Akron 16, Ohio
● Goodyear Tire & Rubber Co., Inc., Chemical Div., 1144 E. Market St., Akron 16, Ohio
Gordon Chemical Co., A & Lombard Sts., Wilmington 99, Del.
Gordon-Lacey Chemical Products Co., Inc., 57–02 48th St., Maspeth 78, N.Y.
Gore, Fred M., 2902 Routh St., Dallas, Texas
Gorrell & Gorrell, 336 Old Hook Road, Westwood, N.J.
Goren, H. L. Co., 2857 N. Halstead St., Chicago 14, Ill.
● Gorton, George, Machine Co., 1100 W. 13th St., Racine, Wis.
Gotham Plastics Corp., 220 E. 134th St., Bronx 51, N.Y.
Gougler, C. L. Machine Co., 705–69 Lake St., Kent, Ohio
Goulding Mfg. Co., 2929 River St., Saginaw, Mich.
● Grace, W. R. & Co., Polymer Chemicals Div., 3 Hanover Sq., New York 5, N.Y.
● Grace, W. R. & Co., Div., Dewey & Almy Chemical Co., 62 Whittemore Ave., Cambridge 40, Mass.
Graf, John C. Co., 1609 Willington, Phila. 21, Pa.
Granbull Tool & Co., Ltd., 39 High St., Kingston-on-Thames, Surrey, England
Grant Chemical Co., 319 Olive St., Santa Barbara, Calif.
Grant & Roth Plastics, Inc., 2311 N.W. Johnson, Portland 10, Ore.
Grauert, R. W. Inc., 100 Gold St., N.Y. 38, N.Y.
Gray, Henry, 814 6th Ave., Seattle, Wash.
Great American Industries, Inc., Rubatex Div., Bedford, Va.
● Great American Plastics Co., 85 Factory St., Nashua, N.H.
Great Lakes Plastic Co., 851 Sycamore St., Buffalo 12, N.Y.
Greeff, R. W. & Co., Inc., 10 Rockefeller Plaza, New York 20, N.Y.
Greene Plastics Corp., Anonchet Road, Hope Valley, R.I.

Greene Ray & Co., 508 So. Byrne Rd. & South St., Toledo 9, Ohio
Greenerd Arbor Press Co., 41 Crown St., Nashua, N.H.
Greenfield, David S., 1489 Plimpton Ave., New York 52, N.Y.
Greer Hydraulic, Inc., 454 18th St., Brooklyn 15, N.Y.
Greer Industries, Inc., N.Y. International Airport, Jamaica 30, N. Y.
Gregstrom Corp., 14 Davis St., Cambridge 39, Mass.
Greif Bros. Cooperage Corp., The, P.O. Box 367, Lindenhurst, N.Y.
Gries Reproducer Corp., 28 Second St., New Rochelle, N.Y.
Grieve-Hendry Co., Inc., 1427 W. Carroll Ave., Chicago 7, Ill.
Griffin, Campbell, Hayes, Walsh, Inc., 50 E. 21st St., New York 10, N.Y.
Griffin Chemical Co., Div., Nopco Chem. Co., 1141 S. 14th St., Richmond, Calif.
Grigoleit Co., The, 740 E. North St., Decatur, Ill.
Groben Supply Co., 1139 S. Wabash, Chicago 5, Ill.
Groov-Pin Corp., 1125 Hendricks Causeway, Ridgefield, N.J.
Grover, Frederic S. Associates, 42 E. Ave., Rochester 4, N.Y.
Growers Container Corp., P.O. Box 11211, Salinas, Calif.
Gruen, Robert Associates, 509 Madison Ave., New York 22, N.Y.
Guild Electronics Inc., Dynatherm Div., 388 Broadway, New York, N.Y.
Guild Molders, Inc., Route 22, Armonk, N.Y.
Gulf Oil Corp., Gulf Bldg., P.O. Box 1166, Pittsburgh, Pa.
Gulliksen, W. M. Mfg. Co., 37 Walnut St., Newton Lower Falls 62, Mass.
Gurley, W. & L.E., 514 Fulton St., Troy, N.Y.
Gusmer, A., Inc., Stalpic Div., Barron Ave., Woodbridge, N.J.

H

H.G.H. Products Co., Inc., 100 Roberts St., Shelton, Conn.
•H.M.S. Assoc., Willow Grove, Pa.
H & O Engineering, Inc., 3747 N. Booth St., Milwaukee 12, Wis.
•H & R Industries, 344 E. Walnut, Nazareth, Pa.
Haas Corp., Mendon, Mich.
Haas Laminator Corp., 108 E. 31st St., New York 16, N.Y.
Hafleigh & Co., Main St., Buchanan, Va.
Haida Engineering Co., 34-11 Vernon Blvd., Long Island City 6, N.Y.
Haines Export & Import Corp., 39 W. 32nd St., New York 1, N.Y.
Hake Mfg. Co., Inc., 1215 Midvale Ave Roanoke, Va.
•Hale & Kullgren Inc., P.O. Box 1231, Akron 9, Ohio
•Hale & Kullgren, Inc., 613 E. Tallmadge Ave., Akron 9, Ohio
•Hale & Kullgren, Inc., Aetna-Standard Engineering Co. Div., 613 E. Tallmadge Ave., Akron, Ohio
Halkey-Roberts Corp., 37 Spring Valley Ave., Paramus, N.J.
Hall, Frances Cushing, Alfred University, P.O. Box 213, Alfred, N.Y.
Haller Plastics Corp., 35-21 20th Ave. L.I.C., 5, N.Y.
Halman Mfg. Co., Inc., Hoosick Falls, N.Y.
Halogen Insulator & Seal Corp., 10121 Franklin Ave., Franklin Park, Ill.
Halsey, Inc., 40 Poplar St., Scranton 9, Pa.
Hamilton Tool Co., The, Ninth St., Hamilton, Ohio
Hammond Machinery Builders, Inc., 1600 Douglas Ave., Kalamazoo, Mich.
Hanley Plastics Co., Div. of Wallace Pencil Co., 2001 S. Hanley Rd., St. Louis 17, Mo.
Hanna Engineering Works, 1771 Elston Ave., Chicago 22, Ill.
Hannifin Corp., 1154D S. Kilbourn Ave., Chicago 24, Ill.
Hanson-Van Winkle-Munning, Church St., Matawan, N.J.
Hanson-Whitney Co., 175 Bartholomew St., Hartford 2, Conn.
Har-Conn Chrome Co., 603 New Park Ave., West Hartford 10, Conn.
Har-E-Dan Engravers, 3089 Fulton St., B'klyn 8, N.Y.
Harbud Associates, 3075 Fulton St., B'klyn 8, N.Y.
•Harchem Div., Wallace & Tierman, Inc., 25 Main St., Belleville 9, N.J.
•H. V. Hardman Co., 571 Cortlandt St., Belleville 9, N.J.
Harkin Affiliates Inc., 331 Madison Ave., New York 17, N.Y.
Harmon, Ira Co., Inc., 331 Madison Ave., New York 17, N.Y.
Harms, Perc. E. Co., 735 Green Bay Rd., Wilmette, Ill.
Harrington & King Perforating Co., The, 5655 Filmore St., Chicago 44, Ill.
Harrison & Co., Inc., 487 Groveland St., Haverhill, Mass.
•Harshaw Chemical Co., The, 1945 E. 97th St., Cleveland 6, Ohio
Harstil Industries Co., 24955 Harper St., St. Clair Shores, Mich.
Hart, William A. & Associates, Route One, Box 278, St. Charles, Ill.
Harte & Co., Inc., 16 E. 34th St., New York 16, N.Y.
•Hartig Engine & Machine Co., 448 Hillside Ave., Hillside, N.J.
Hartland Plastics, Inc., Maple Ave., Hartland, Wis.
Hartman, Geo. H. Co., 307 N. Michigan Ave., Chicago I, Ill.
Hartshorn, Stewart Co., 8 E. Utica St., Oswego, N.Y.
Harvey, Guy P. & Son Corp., 40 Spruce St., Leominster, Mass.
•Harwick Standard Chemical Co., 60 S. Seiberling St., Akron 5, Ohio
Haskelite Mfg. Corp., 701 Ann St., N. W., Grand Rapids 2, Mich.
Hassall, John Inc., Cantiague Rd., N.Y.
Hatco Chemical Co., King George Rd., P.O. Box 309, Fords, N.J.
Hathaway Kraemer LTD., 125 Whitney Pl., Kitchner, Ont., Canada
Hauser, Jos W. Inc., St. Chas. Nat'l. Bank Bldg., St., Charles, Ill.
Haveg Industries, Inc., 900 Greenbank Rd., Wilmington, Del.
•Hawley Products Co., 333 North 6th St., St. Charles, Ill.
•Hayden Mica Co., Main St., Wilmington, Mass.
Haynes, C. W., Laboratories, Inc., 61 Chandler St., Springfield 4, Mass.
Hays Mfg. Co., Reinforced Plastics Div., 801 W. 12th St., Erie 1, Pa.
Heath Die Co., 382 Lafayette St., New York 3, N.Y.
Hedwin Corp., 1600 Roland Heights Ave., Baltimore 11, Md.
Heil Process Equipment Corp., 12901 Elmwood Ave., Cleveland 11, Ohio
Heinrich, H. H. Co., 111 Eighth Ave., New York 11, N.Y.
Heli-Coil Corp., Shelter Rock Lane, Danbury, Conn.
Helicoid Gage Div., American Chain & Cable Co., 929 Conn. Ave., Bridgeport 2, Conn.
Helmuth Tool & Die Co., 5 Sherman St., Linden, N.J.
Hempstead Marine Service, Keystone Hts., Fla.
Hendrick Mfg. Corp., 11 Selman St., Marblehead, Mass.
Henriques, J. B. Inc., 521 5th Ave., New York 17, N.Y.
Henry Keck Associates, 660 S. Fair Oaks Ave., Pasadena 2, Calif.
Heppenstall Co., 4620 Hatfield St., Pittsburgh, Penna.
Herbert Products Inc., 74-32 Jamaica Ave., Woodhaven 21, N.Y.
Herblin Corp., The, 3000 Burns Ave., Wantagh, L.I., N.Y.
Hercules Powder Co., Inc., 9th & Market Sts., Wilmington 99, Del.
Hermann Berstoff Maschinenblau-Anstalt G.M.B.H., An der Breiten Wiese, Hannover, W. Germany
Hernand Mfg. Co., Inc., 923 Old Nepperhan Ave., Yonkers, N.Y.
Hero Mfg. Co., Inc., 15 Sprout St., Middleboro, Mass.
Hes Electrical Mfg. Corp., 10829 E. Central Ave., El Monte, Calif.
Hewitt, C. B. & Bros., Inc., 23-25 Greene St., New York 13, N.Y.
•Hexcel Products Co., 955-61st St., Oakland 8, Calif.
•Heyden Chemical Corp., 342 Madison Ave., New York 17, N.Y.
Hibbert, R. F. Company, New Canaan, Conn.
Hibbert-Patton Inc., 15 Meadow St., S. Norwalk, Conn.
High Vacuum Equipment Corp., 349 Lincoln St., Hingham, Mass.
High Vacuum Metals, Inc., 40 Worth St., New York, N.Y.
Hinde & Dauch Paper Co., 407 Decatur St., Sandusky, Ohio
•Hobbs Mfg. Co., 26 Salisbury St., Worcester 5, Mass.
Hocking Plastics Co., Carbon Hill, Ohio
•Hofmann & Schwabe K. G., Wilhelmshofallee 96, Krefield, W. Germany
Hoffman Industries, Inc., 345 E. Main St., Spring Arbor, Mich.
Holes, Floyd A. Co., The, 100 Northfield Rd., Bedford, Ohio
Holiday Plastics Inc., 410 E. 27th Terrace, Kansas City, Mo.
•Holland, M. Co., 225 N. Racine Ave., Chicago 7, Ill.
Hollander, Allen Co., Inc., 385 Gerard Ave., Bronx, N.Y.
Hollywood Plastic Arts, 515 E. 9th St., Los Angeles 15, Calif.
Holstein, Lee, Injection Molding Ind., 53 Orchard St., Clifton, N.J.
Homalite Co., The, 11-13 Brookside Dr., Wilmington, Del.
•Hommel, O. Co., The, 209 Fourth Ave., Pittsburgh 22, Pa.
Honeycomb Co. of America, Inc., 3 Burroughs St., Bridgeport 8, Conn.
Honeycomb Structures Co., Inc., 5510 W. 102nd St., Los Angeles 45, Calif.
•Honolulu Oil Corp., Industrial Research Labs. Div., 961 E. Slauson Ave., Los Angeles 11, Calif.
Hood Sponge Rubber Co., 340 W. Huron St., Chicago 10, Ill.

•Indicates Advertiser.

● **Hooker Electrochemical Co.**, 25 Forty-seventh St., Niagara Falls, N.Y.
● **Hopp Press**, 460 W. 34th St., New York 1, N.Y.
Houghton, E. F. & Co., 303 W. Lehigh Ave., Phila. 33, Pa.
Houghton Laboratories, Inc., 322 Houghton Ave., Olean, N.Y.
Howards & Sons Ltd., 247 Dunbar Ave., Montreal 16, Ontario, Canada
Howell, James A & Marie, 404 Benefit St., Providence 3, RI.
Hubbard Reinforced Plastic Corp., 4533 W. Harrison, Chicago 24, Ill.
Huber, J. M. Corp., 100 Park Ave., New York 17, N.Y.
Hudson Foam Plastics Corp., Lake Ave. & Sawmill River Rd., Yonkers, N.Y.
Hughes, Henry, 1440 Old County Rd., Belmont, Calif.
Hughes Glue Co., 3500 St. Aubin, Detroit 7, Mich.
Hughes Plastics Inc., 723 Pleasant St., St. Joseph, Mich.
Hughes Tool & Mfg., 279 Ninth St., Benton Harbor, Mich.
● **Hull-Standard Corp.**, Abington, Pa.
Hunt, Rodney Machine Co., 130 Mill St., Orange, Mass.
Hunton Plastics Co., 178 S. Van Brunt St., Englewood, N.J.
● **Hurlbut Paper Co.**, South Lee, Mass.
Huron Valley Plastics, 1035 S. Main, Ann Arbor, Mich.
Huxtable, L. Garth A.S.I.D., 46 E. 76th St., New York 21, N.Y.
Hy-Sil Mfg. Co., Revere 51, Mass.
Hyade Park Engineering, Rt. 6, Box 384, Tacoma, Wash.
● **Hyde, A. L. Co.**, Main St., Grenlock, N.J.
● **Hydraulic Press Mfg. Co.**, 1012 Marion Rd., Mt. Gilead, Ohio
Hydraulic Press Mfg. Co., The, 5301 Pacific Blvd., Huntington Park, Calif.
Hydrawlik Co., 131 E. 1st Ave., Roselle, N.J.
Hydro-Chemie Ltd., Dreikoenigstrasse 21, Zurich, Switz.
Hydro Molding Co., Inc., 100 Sharron Ave., Plattsburg, N.Y.
Hynes Electric Heating Div., Turbine Equipment Co., P.O. Box 578, Westfield, N.J.
Hypro Tool Co., 459 Mt. Pleasant St., New Bedford, Mass.
Hy-Sil Mfg. Co., Revere 51, Mass.

I

Ideal Gold Stamping Co., 990-6th Ave., New York, N.Y.
Ideal Industries, Inc., Sycamore, Ill.
● **Ideal Plastics Corp.**, 184-10 Jamaica Ave., Hollis 7, N.Y.
Identification Service Corp., 144 W. 46th St., New York 36, N.Y.
Illinois Testing Labs., Inc., 420 N. La-Salle St., Chicago 18, Ill.
Illinois Tool Works, Shakeproof Div., 2501 N. Keeler Ave., Chicago 39, Ill.
Imbello, Ray, 204 Bergen Blvd., Fairview, N.J.
Imco Container Corp., 75th & Cleveland Sts., Kansas City, Mo.
● **Imperial Chemical Industries Ltd., Plastics Div.**, Black Fan Rd., Weywyn Garden City, Hertfordshire, England
Imperial Industries, Inc., 4436 Walker Ave., Wayne, Mich.

● Indicates Advertiser.

Imperial Molded Products Corp., 2925 W. Harrison St., Chicago 12, Ill.
Imperial Paper & Color Corp., Glens Falls, N.Y.
● **Improved Machinery Inc.**, 150 Burke St., Nashua, N.H.
Improved Paper Machinery Corp., Plastic Molding Machinery Div., 150 Burke St., Nashua, N.H.
Independent Die & Supply Co., 2641 La Salle St., St. Louis 4, Mo.
Index Machinery Corp., 4907 Foley Rd., Cincinnati 38, Ohio
Industrial Devices, Inc., 928 River Rd., Edgewater 19, N.J.
Industrial & Domestic Silicone Distributor, 6206 Yarmouth Ave., Resede, Calif.
Industrial Engineering Service, Washington St., S. Easton, Mass.
Industrial Gauges Corp., 1500 Queen Ann Rd., Wenglewood. N.J.
● **Industrial Heater Co., Inc.**, 245 Canal St., New York 13, N.Y.
Industrial Latex Co., 306 Mt. Pleasant Ave., Wallington, N.J.
● **Industrial Mfg. Corp.**, 31 E. Georgia, Indianapolis 4, Ind.
● **Industrial Molded Products Co.**, 5201 N. Avondale Ave., Chicago 30, Ill.
Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio
● **Industrial Ovens, Inc.**, 13825 Triskett Rd., Cleveland 11, Ohio
Industrial Plastic Co., 216 Tingley Lane, Metuchen, N.J.
Industrial Plastic Fabricators, Inc., Endicott St., Norwood, Mass.
Industrial Plastic Fittings Co., 3891 W. 150th St., Cleveland, Ohio
Industrial Plastic Supply Co., 574 New Park Ave., W. Hartford 10, Conn.
Industrial Plastics Corp., 816 W. Beardsley, Elkhart, Ind.
Industrial Plastics Corp., Div., Thompson, H. I. Fiber Glass Co., 1526 W. 166th St., Gardena, Calif.
Industrial Rayon Corp., 500 Fifth Ave., New York 36, N.Y.
● **Industrial Research Labs.**, 961 E. Slauson Ave., Los Angeles 11, Calif.
Industrial Sales Engineers, 511 Fifth Ave., New York 17, N.Y.
● **Industrial Solvents & Chemicals, Inc.**, Depot, Wilkinsonville, Mass.
Industrial Synthetics Corp., 225 North Ave., Garwood, N.J.
Industrial Vinyls, Inc., 5511 N. W. 37th Ave., Miami, Fla.
Industron Corp., 55 Needham St., Newton Hlds., Mass.
Ingwersen Mfg. Co., Inc., 1870 S. Acoma St., Denver 23, Colo.
● **Injection Molders Supply Co.**, 3514 Lee Rd., Cleveland 20, Ohio
Injection Molding Corp., 113 4th Ave., New York 3, N.Y.
Inland Container Corp., 700 W. Morris St., Indianapolis 6, Indiana
Innes, O. G. Corp., 82 Wall St., New York 5, N.Y.
Innis, Speiden & Co., Inc., 420 Lexington Ave., New York 17, N.Y.
Insulating Fabricators of New England, Inc., 69 Grove St., Watertown 72, Mass.
● **Insulation Manufacturing Co., Inc.**, 11 New York Ave., Brooklyn 16, N.Y.
Insulation Products Co., P.O. Box 5679, Pittsburgh 8, Pa.
Inta-Roto Machine Co., The, P.O. Box 454, Richmond 3, Va.
● **Interchemical Corp.**, 67 W. 44th St., New York 36, N.Y.
● **Interchemical Corp., Finishes Div.**, 224 McWhorter St., Newark, New Jersey
● **Interchemical Corp., Printing Ink Div.**, 67 W. 44th Street, New York, N.Y.
● **Interchemical Corp., R-B-H- Dispersions Div.**, 2 Hamilton St., Bound Brook, N.J.
Intercontinental Dynamics Corp., 170 Coolidge Ave., Englewood, N.J.
International Balsa Corp., Boyd Ave., Jersey City, N.J.
International Engraving Corp., 36 Commerce Rd., Cedar Grove, N.J.
International Filler Corp., 200 Bridge St., N. Tonawanda, N.Y.
International Marking Machine Co., 801 6th Ave., New York, N.Y.
International Molded Plastics, Inc., 4387 W. 35th St., Cleveland 9, Ohio
International Packings Corp., Bristol, New Hampshire
International Plastic Co., 1950 Third Ave., New York 29, N.Y.
International Plastics Co., 2515 W. 18th St., Chicago, Ill.
International Plastics Corp., 506 Monger Bldg., Elkhart, Ind.
International-Plastics, 27 E. 33rd St., Paterson, N.J.
International Printing Ink, 67 W. 44th St., New York 18, N.Y.
International Processes, Inc., 624 S. Michigan, Chicago, Ill.
International Rubber & Plastics Co., Div., Lefton Iron & Metal Co., 521 Spruce St., St. Louis 2, Mo.
International Textile Co., 2511 W. 18th St., Chicago 8, Ill.
● **Interplastics Corp.**, 654 Madison Ave., New York 21, N.Y.
Intraplast Mfg. Co., 1947 Broadway, New York 23, N.Y.
Ironsides Resins, Inc., 270 W. Mound St., Columbus, Ohio
Irvington Varnish & Insulator, Div., Minnesota Mining & Mfg. Co., 6 Argyle Terrace, Irvington 11, N.J.
● **Irvin, Jewell & Vinson Co.**, 17 E. 3rd St., Dayton, Ohio
Island Equipment Corp., 27-01 Bridge Plaza N., L.I.C. 1, N.Y.
Isocyanate Products Inc., P.O. Box 1681, Wilmington, Del.
Isotope Products, 1711 Elmwood Ave., Buffalo 7, N.Y.

J

J. B. Products Corp., 1745 N. Ashland Ave., Chicago 22, Ill.
Jackson & Church Co., 321 N. Hamilton Saginaw, Mich.
Jacobs, H. G. Mfg. Co., 159-167 Lin-Wood Ave., Peterson 2, N.J.
Jalce Tool Co., 140 Johnson Ave., Bklyn. 6, N.Y.
James & Laughlin, 3 Gateway Center, Pittsburgh, Pa.
James Industries, Inc., Paoli, Pa.
Jamestown Finishes, Inc., 125 Blackstone Ave., Jamestown, N.Y.
Jamison Plastic Corp., 1255 Newbridge Rd., N. Bellmore, N.Y.
Jarvis Corp., Pease Ave., Middletown, Conn.
Jason Corp., 1040 Grand St., Hoboken, N.J.
● **Jay, T. V. Co.**, 2227 W. Belmont, Chicago 18, Ill.
Jefferson Chemical Co., Inc., 260 Madison Ave., New York 16, N.Y.
Jema Chemical & Supply Co., 191 South St., Newark 5, N.J.

Jersey Plastic & Die Casting Co., 149 Shaw Ave., Irvington 11, N.J.
Jessall Plastics, Inc., 889 Farmington Ave., Kensington, Conn.
Jet Specialties Co., Inc., 941 N. Eastern Ave., Los Angeles, 63, Calif.
Joachim Research Labs., Inc., 120 Liberty St., New York 6, N.Y.
Joana Western Mills Co., 22nd & Jefferson St., Chicago 16, Ill.
Joclin Mfg. Co., 9 Philip Place, North Haven, Conn.
Jodee Plastics Co., 213 Shepherd Ave., Bklyn 8, N.Y.
Johns-Manville, 22 E. 40th St., New York 16, N.Y.
Johns-Manville, Van Cleef Bros., Inc., Div., 7800 Woodlawn Ave., Chicago 19, Ill.
•Johnson Glass & Plastic Corp., 5248 Elston Ave., Chicago 30, Ill.
•Johnson Machinery Co., 679 Frelinghuysen Ave., Newark, N.J.
•Johnson Mfg. Co., 229 S. Main St. Chippewa Falls, Wis.
Johnson Plastic Corp., Brown & Stafford Rds., Chagrin Falls, Ohio
Johnson, S. C. & Son, Inc., 1525 Howe St., Racine, Wis.
Johnson, S. T. Co., Mears Kane Ofeldt, Inc., Div., Church Rd., Bridgeport, Pa.
Johnstone Engineering & Machine Co., First Ave., & Gay St., Parkesburg, Pa.
Joliet Plastic, Inc., 15 South Joliet St., Joliet, Ill.
Jomac, Inc., 6128 N. Woodstock St., Philadelphia 38, Pa.
Jones, B. M. Co., Emerson Ave., Gloucester, Mass.
Jones, C. Walker Co., 6135 N. Lambert St., Phila. 38, Pa.
Jones-Dabney Co., 1481 S. 11th St., Louisville 8, Ky.
Jordan Mfg. Co., 1850 Miner St., Des Plaines, Ill.
Juno Tool Corp., 951 E. Hennipin Ave., Minneapolis 14, Minn.
Jupiter Plastics, Inc., 103 Hawthorne Ave., Pittsfield, Mass.
Just Plastics Inc., 256 W. 65th St., New York 23, N.Y.

K

K B Plastics Inc., 29 A St., Ephrata, Wash.
K-S-H- Plastics, Inc., Highway 30, High Ridge Mo.
Kabar Mfg. Corp., 1907 White Plains Rd., New York 62, N.Y.
Kage Co., 130 Hartford Rd., Manchester, Conn.
Kahn, Geo. N. Co., 350 5th Ave., New York, N.Y.
Kakor Industries, Inc., Yardville, N.J.
Kalistron Inc., 1122 Dumesnil, Louisville, Ky.
•Karlton Machinery Corp., 210 E. Ohio St. Chicago 11, Ill.
Kassel Export Co., 9-11 Broadway, New York 4, N.Y.
Kaumagraph Co., 14th & Poplar Sts., Wilmington 99, Del.
Kay Fries Chemicals, Inc., 180 Madison Ave., New York 16, N.Y.
Kaye Plastics Corp., P.O. Box 1149, New Brunswick, N.J.
Kaye-Tex Mfg. Corp., 110 E. 23rd St., New York 10, N.Y.
Kaye-Tex Mfg. Corp., 4407 S. Broad St., Yardville, N.J.
Keck, Henry Associates, 660 S. Fair Oaks Ave., Pasadena 2, Calif.
Keepsake Shops, 48th St. Station, Union City, N.J.
Kehr Products Co., 401 N. Broad St., Phila. 8, Pa.
Kel-Min Co., The, Middlefield, Ohio
Keller Products, Inc., 3099 Vine Court, Cleveland 13, Ohio
Keller Products, Inc., 41 Union St., Manchester, N.H.
Kellering, Victor, Inc., 955 E. 51st St., Bklyn 3, N.Y.
Kellogg Div., American Brake Shoe Co., 97 Humboldt & Coventry, Rochester 9, N.Y.
Kellogg, M. W. Co., The, P.O. Box 469, Jersey City 3, N.J.
Kelly, George A., 215 East Main St., Fredericktown, Mo.
Kemtek Corp., 206 Sylvan Ave., Newark 4, N.J.
Kendall Co., The, 309 W. Jackson Blvd., Chicago, 6, Ill.
Kenly Co., Terre Haute, Ind.
Kennedy, R. J. Co., 820 San Mateo Ave., San Bruno, Calif.
Kennerly-Spratling Inc., 1456-4th St., Berkeley 10, Calif.
Kenly Co., 1001-N. 10th St., Terre Haute, Ind.
Kenrich Corp., 57-02 48th St., Maspeth 78, N.Y.
Kent Cliff Laboratories, Div., Torsion Balance Co., The, Monhegan St., Clifton, N.J.
Kent Plastics Corp., 1528 N. Fulton Ave., Evansville 10, Ind.
•Kentucky Color & Chemical Co., 600 N. 34th St., Louisville 12, Ky.
•Keolyn Plastics, Inc., 2731 N. Pulaski, Chicago 39, Ill.
Kerr, Alexander H. & Co., Inc., 3440 Wilshire Blvd., Los Angeles 5, Calif.
Kerr Industries, 105 W. Spazier St., Burbank, Calif.
Kerr, R. W. Plastic Co., 220 Burlington Ave., S. Hastings, Nebr.
Kerrco Products, 4335 N. 61st St., Lincoln 7, Nebr.
Kesich Mfg. Co., Inc., 10 Esplanade Ave., Pitman 3, N.J.
Kessler Chemical Co., Inc., State Rd. & Cottman Ave., Philadelphia 35, Pa.
Ketchpel Engineering Co., 1401-05 Palisade Ave., W. Englewood, N.J.
Keuffel & Esser Co., 300 Adams St., Hoboken, N.J.
Keyes Fibre Co., Upper College Ave., Waterville 17, Me.
Keyes Fibre Sales Co., 420 Lexington Ave., New York 17, N.Y.
Keystone Brass Works, Inc., Applied Plastics Div., 1102 W. 12th St., Erie, Pa.
Keystone Packaging Service, 1012 Washington St., Easton, Pa.
Keystone Plastic Engineering Co., 1272 N. Wood St., Chicago 22, Ill.
Keystone Refining Co., Inc., 4821-31 Garden St., Philadelphia 37, Pa.
•Killion Tool & Mfg. Co., 56 Depot St., Verona, N.J.
Kimberly-Clark Corp., Technical Papers Div., Neenah, Wis.
Kindt-Collins Co., 12651 Elmwood Ave., Cleveland 11, Ohio
King Designers, 13118 W. Chicago Ave., Detroit 28, Mich.
•King Machine Tools Div., American Steel Foundries, 1177 Tennessee Ave., Cincinnati 29, Ohio
•Kingman, E. B. Co., 96 Exchange St., Leominster, Mass.
Kingsbacker-Murphy Co., 6245 Lexington Ave., Hollywood 38, Calif.
•Kingsley Stamping Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif.
Kirk, F. J. Molding Co., Inc., 140 Brook, Clinton, Mass.
Kirk-Blum Mfg. Co., 2838 Spring Grove Ave., Cincinnati 25, Ohio
Kirn, G. C. Sign Co., 2737 Washington Ave., St. Louis 3, Mo.
Klauder, Weldon & Giles Co., Adams & Heiper Sts., Phila. Pa.
Kleen-Stik Products Inc., 7300 W. Wilson Ave., Chicago 31, Ill.
Kleestron Ltd., West Halkin St., London S.W. 1, Eng.
Kleinzway, Inc., Engineering Div., S. Oakley Ave. at 49th St., Chicago 9, Ill.
Klingrose Div., American Type Founders Sales Corp., Elizabeth, N.J.
Klise Mfg. Co., 50 Cottage Grove St., Grand Rapids 2, Mich.
Klisey Engineering Company, 4407 Union Pacific Avenue, Los Angeles 23, Calif.
Klug Eng. Service, 216 S. Mansfield Ave., Los Angeles, Calif.
Knoedler Chemical Co., 651 High St., Lancaster, Pa.
Knuth Eng. Co., 2617 N. St. Louis Ave., Chicago 47, Ill.
Koch Mfg. Co., 319 W. Main St., Jackson, Mo.
Kogan, Belle Associates, 145 E. 35th St., New York 1, N.Y.
Kohnstamm, H. & Co., Inc., 87 Park Pl., New York 7, N.Y.
Kolker Chemical Corp., 600 Doremus Ave., Newark 5, N.J.
Koller Craft Plastic Products, Inc., Fenton, Mo.
•Koppers Co., Inc., Chemical Div., Koppers Bldg., Pittsburgh 19, Pa.
Kopplin Molding Corp., 1440 Blair Ave., St. Louis 6, Mo.
Korris Products, Inc., 4400 Lawndale Ave., Lyons, Ill.
Kraissel Co., Inc., Williams Ave., Hackensack, N.J.
Kraloy Plastic Pipe Co., 4710 E. Washington Blvd., Los Angeles 22, Calif.
•Kramer, H. W. Co., Inc., 120-30 Jamaica Ave., Richmond Hill 18, N.Y.
Kreidl Chemico-Physical Co., The, 81 E. State St., Columbus 15, Ohio
•Krieger Color & Chemical Co., Inc., 6531 Santa Monica Blvd., Los Angeles 38, Calif.
Krumhaar Chemicals, Inc., 23-30 Jacobus Ave., S. Kearny, N.J.
Krylon, Inc., 18 W. Airy St., Norristown, Pa.
Kuhlman Plastics Co., Inc., 3734 Gardner Ave., Kansas City, Mo.
•Kuhn & Jacob Molding & Tool Co., 1200 Southard St., Trenton 8, N.J.
Kulite Tungsten Co., 723 Sip St., Union City, N.J.
Kunst, John Co., The, 41 Murray St., New York 7, N.Y.
•Kurz-Kasch Inc., 1421 S. Broadway Dayton 1, Ohio
Kusan, Inc., 2716 Franklin Rd., Nashville, Tenn.
Kwik-Mold Plastic Corp., 247 W. 67th St., New York 23, N.Y.

L

LOF Glass Fibres Co., 1810 Madison Ave., Toledo 2, Ohio

•Indicates Advertiser.

L & P Tool Co., 4354 Hamilton Ave., Cincinnati, Ohio
La Rose, W. T. & Associates, Inc., Troy, N.Y.
Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N.Y.
Lacquer Specialties, Inc., 249-263 Ave. P, Newark, N.J.
Lacrinoid Products Ltd., Stafford Ave., Gidea Park, Essex, England
Lafayette Saw & Knife Co., 85 Guernsey St., Brooklyn 22, N.Y.
Lake Chemical Co., 3052 W. Carroll Ave., Chicago 12, Ill.
●Lake Erie Engineering Corp., 869 Woodward Ave., Buffalo 17, N.Y.
Lake Erie Plastics Co., 140 Woodbury St., Elyria, Ohio
Lamex Chemical Corp., One Sundial Ave., Manchester, N.H.
Lami-Plast Products Co., 4619 Wishart Blvd., Tampa, Florida
Lamicell Engineering Co., 122-128 W. 10th St., Baxter Springs, Kansas
Laminate Industries, Inc., 923 Old Nepperhan Ave., Yonkers, N.Y.
Laminated Fiberglass Corp. of America, 120 Broadway, New York 5, N.Y.
Laminated Sheet Products Corp., 449 Neponset, St., Norwood, Mass.
●Laminations, Inc., 1008 S. Irving Ave., Scranton, Pa.
Lami-plast Products Co., 4701 Wishart Blvd., Tampa 3, Fla.
Lamson Corp., Syracuse 1, N.Y.
Landers-Segal Color Co., 78 Delavan St., Brooklyn 31, N.Y.
Lane J. H. & Co., Inc., 250 W. 57th St., New York 19, N.Y.
Lanly Co., The, 750 Prospect Ave., Cleveland 15, Ohio
Lapeer Plastics, Inc., 2214 Franklin St., Manitowoc, Wis.
Lapeer Mfg. Co., 3056 Davison Rd., Lapeer, Mich.
Lapin Products, Inc., 164 Delancy St., Newark, N.J.
●Larc Products, Inc., Box 327, Amsterdam, N.Y.
Latrobe Steel Co., 2626 Ligonier St., Latrobe, Pa.
Lautin Plastics, Inc., 2004 McDonald Ave., Brooklyn 23, N.Y.
Lavorazione Materie Plastiche, Nicomede Bianchi 72, Torino, Italy
Lawrence Adhesive & Chemical Co., Inc., 19 S. Canal St., Lawrence, Mass.
Lawrence Process Co., 1 Clark St., North Andover, Mass.
Lawson, E. P. Co., Inc., 426 W. 33rd St., New York 1, N.Y.
●Lawton, C. A. Co., 240 Broadway, De Pere, Wis.
Lawtonson Plastics, Inc., P.O. Box No. 231, New Hyde Park, L.I., N.Y.
Le Page's Inc., Essex St., Gloucester, Mass.
Lea Mfg. Co., The, 16 Cherry Ave., Waterbury 20, Conn.
●Leaf Plastics, Inc., 135 Woodworth Ave., Yonkers, N.Y.
Leaty, The Phillip Co., 100 W. Monroe St., Chicago 3, Ill.
Leathertone, Inc., 260 Tremont St., Boston 16, Mass.
Lebec Chemical Corp., 14066 S. Garfield Ave., Paramount, Calif.
Lee, Walter Chemical Corp., 1383 Seabury Ave., Bronx 61, N.Y.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.

●Lehmann, J. M. Co., Inc., Thropp, Wm. R. & Sons Co., Div., 550 New York Ave., Lyndhurst, N.J.
Leiman Bros, Inc., 166 Christie St., Newark 5, N.J.
Lembo Machine Works Inc., 248 E. 17th St., Paterson 4, N.J.
●Lemmon & Snoap, 286 Bridge, N. W., Grand Rapids 4, Mich.
Lenco, Inc., 350 W. Adams St., Jackson, Mo.
Leominster Tool Co., Inc., 272 Whitney St., Leominster, Mass.
Lermer Plastics, Inc., 502 South Ave., Garwood, N.J.
Les Machines Foucher, 30 Avenue Jean-Jaures Arcueil (Seine), France
Leslie Co., Grant Ave., Lyndhurst, N.J.
Lester Engineering Co., 2711 Church Ave., Cleveland 13, Ohio
●Lester-Phoenix, Inc., 2711 Church Ave., Cleveland 13, Ohio
Levey, Harold A. Laboratories, 8127-33 Oleander St., New Orleans 18, La.
Levin, Monte L., 501 Madison Ave., New York 22, N.Y.
Levitt, Samuel, 423 W. Coulter St., Philadelphia 44, Pa.
Lewis, G. B. Co., 426 Montgomery St., Watertown, Wis.
Lewis J. P. Co., The, Beaver Falls, N.Y.
●Lewis Welding & Engineering Corp., 1 Interstate St., Bedford, Ohio
●Liberty Cutting Die Co., 39 Great Jones St., New York 12, N.Y.
●Liberty Machine Co., Inc., 275 Fourth Ave., Paterson 4, N.J.
Liberty Plastics Co., 50 Grant St., Woodstown, N.J.
Liberty Tool, 275 4th Ave., Paterson, N.J.
●Liberty Tool & Machine Co., 18 S. 20th St., Irvington 11, N.J.
Libo Plastics Co., 4677 N. 45th St., Milwaukee 16, Wis.
Lignum Chemical Works, The, 37-10 Review Ave., Long Island City 1, New York
Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.
Lincoln Molded Plastics Corp., 13 Marshall St., S. Norwalk, Conn.
●Lincoln Molded Plastics, Inc., Corwin & Clinton Sts., Circleville, Ohio
Lind Plastic Products Inc., 6900 N. Central Pk., Lincolnwood, Ill.
Lindsay, John, 2475 W. 26th Ave., Denver 11, Col.
Linehan & Co., 2062 Irving Blvd., Dallas 7, Texas
Linley Bros. Co., 682 State St., Extension, Bridgeport 1, Conn.
Lippincott & Margulies, Inc., 430 Park Ave., New York 22, N.Y.
Liquid Casting Systems, 125 65th St., West New York, N.J.
Liquid Plastics Corp., 50-02 23rd St., L.I.C., N.Y.
Lithgow Chemical Co., Div. of Reinhold Engineering & Plastics Co., 12827 E. Imperial Highway Norwalk, Connecticut
Lithgow, James Co., Inc., 1313 W. Sepulveda, Torrence, Calif.
●Litzler, C. A. Co., Inc., 11621 Detroit Ave., Cleveland 2, Ohio
Lockheed Aircraft Co., Burbank, Calif.
●Lodge & Shipley Co., 3055 Colgrain Ave., Cincinnati, Ohio
Loed Chemical Corp., 2068 S. Queen St., York, Pa.
Loewinger Mold Engineering Co., 299 Pacific St., B'klyn 2, N.Y.

●Logan Engineering Co., 4901 Lawrence Ave., Chicago 30, Ill.
●Logo, Inc., 12933 S. Stony Island Ave., Chicago 33, Ill.
Loma Plastics Inc., 3000 W. Pafford St., Ft. Worth, Texas
●Lombard Governor Corp., Ashland, Mass.
Lone Star Boat Mfg. Co., 1930 E. Main, Grand Prairie, Texas
Lone Star Plastics Co., Inc., 124 Roberts Cut-off Rd., Fort Worth, Texas
Long Island Engraving Co., 120-06 22nd Ave., College Pt. 56, N.Y.
Long, Thomas, J., Inc., 215 Stonehinge Lane, Carle Pl., L.I., N.Y.
Long-Bell Lumber Co., Longview, Wash.
Loomis Engineering & Mfg. Co., 126 S. 14th St., Newark 7, N.J.
●Lor-El Co., 252 Paterson Plank Rd., Jersey City 7 N.J.
Loranger Plastics Corp., 36 Clark St., Warren, Pa.
Lord Chemical Corp., 2068 S. Queen St., York, Pa.
Loven Chemical of Calif., 244 S. Pine St., Newhall, Calif.
Lovick, James & Co., Ltd., 1010 St. Catherine St., W., Montreal 2, Quebec, Canada
Loxite Sales Div., Xylos Rubber Co., Div., Firestone Tire & Rubber Co., Akron 1, Ohio
●Lucidol Div., Wallace & Tiernan Inc., 1740 Military Rd., Buffalo 5, N.Y.
Ludascher, William C., 1110 Beverly Rd., Eddington, Pa.
Lumar OPT. Mfg. Co., Inc., 133 S. Terrace Ave., Mt. Vernon, N.Y.
Lumelite Corp., Pawling, N.Y.
●Luminous Resins Inc., 166 W. Washington St., Chicago 2, Ill.
Lumite Div., Chicopee Mills, Inc., 40 Worth St., New York 13, N.Y.
Lunn Laminates, Inc., Oakwood Rd. & W. 11th St., Huntington Station, N.Y.
●Lupoline Automatic Polishing Equipment Corp., 99-111 Columbus Ave., Tuckahoe 7, N.Y.
Luria-Cournand, Inc., Havre De Grace, Md.
Lurie Plastics, Inc., 1913 Boulevard, Colonial Heights, Va.
Lus-Trus Corp., 884 Railroad St., Ypsilanti, Mich.
Lustra City Industries, Inc., 331-335 Kent Ave., B'klyn. 11, N.Y.
Luzerne Rubber Co., Muirhead Ave., Trenton 7, N.J.
●Lydon Bros., Inc., 85 Labriskie St., Hackensack, N.J.
Lynch Asbestos Co., 2939 S. Sonal Dr., Los Angeles 23, Calif.
Lyntex Corp., 40 East 34 St., New York, N.Y.

M

●M & N Hydraulic Press Co., 780 Rt. 3, Clifton, N.J.
MCI Plastic Corp., Greenville Rd., Rd #1, Lakewood, N.J.
Macbeth Corp., Little Britain Rd., Newburgh, N.Y.
MacDonald Mfg. Co., 550 Green, New Baltimore, Mich.
MacMillin Engineering Corp., 3999 N. 25th Ave., Schiller Park, Ill.
Machine Factory & Foundry Ltd., Netstal, Switzerland
Les Machines Foucher, 30 Ave Jean-Jourer, Arcueil, (Seine) France
●Mack Molding Co., Inc., Rayerson Ave., Wayne, N.J.

●Indicates Advertiser.

Madan Plastics Inc., 370 North Ave., Cranford, N.J.
Mager & Gougelman, 1641 W. Carroll Ave., Chicago 12, Ill.
Magic Chemical Co., 120 Crescent St., Brockton 2, Mass.
Magnetic Engineering & Mfg. Co., Van Houten & Erie Ave., Clifton, N.J.
•Magnetic Pigment Div., Columbian Carbon Co., 601 Cass St., Trenton 10, N.J.
Maimin, H., Co., Inc., 575–8th Ave., New York 18, N.Y.
Main, Robert A. & Sons, Inc., 259 Polecat Rd., Paramus, N.J.
Majestic Creations, Inc., 37–03 Woodside Ave., Woodside 77, N.Y.
Majestic Extruders, Inc., 458 W. 168th St., New York 32, N.Y.
Majestic Molded Products, Inc., 845 E. 138th St., Bronx 54, N.Y.
Majestic Molding Co., 805 W. River Rd., Elyria, Ohio
•Makray Mfg. Co., 4400 N. Harlem Ave., Chicago 31, Ill.
Malco Plastics, Inc., 4100 Plastics Pl., Baltimore 9, Md.
Mallinckrodt Chemical Works, 2nd & Mallinckrodt Sts., St. Louis 7, Mo.
Mallory Plastics Co., 3670 Milwaukee Ave., Chicago 41, Ill.
Manchester Molding Co., Manchester, Vt.
Manco Products, Inc., 2401 Schaefer Rd., Melvindale, Mich.
Manhasset Machine Co., 225 E. 2nd St., Mineola, L.I., N.Y.
Manhattan & Electronic Die Co., 37 W. 17th St., New York, N.Y.
Mankato Paper Box Co., 726 S. Front St., Mankato, Minn.
Manne-Knowlton Insulation Co., Inc., 416 W. 13th St., New York 14, N.Y.
Mannesmann-Easton Plastic Products Co., Inc., 900 Line St., Easton, Pa.
Manufacturer's Corp., 104 Ausdale Ave., Mansfield, Ohio
Many, J. & Co., 153 Lafayette St., New York 13, N.Y.
•Mapico Color Div., Columbian Carbon Co., 601 Cass St., Trenton 10, N.J.
Maplewood Companies, P.O. Box 113, Livingston, N.J.
Marbak, Inc., 1200 Manhattan Ave., B'klyn 22, N.Y.
•Marblette Corp., The, 37–21 30th St., Long Island City 1, N.Y.
•Marbon Chemical Div., Borg-Warner Corp., 1926 W. Tenth Ave., Gary, Ind.
•Marco Products Dep't., Celanese Corp. of America, 290 Ferry St., Newark 5, N.J.
Marine Controls Lab., Dixie Plastic Div., 3017 N. Galvez St., New Orleans, La.
Marine Plastics, Inc., School St., Clinton, Mass.
Markal Co., 3052 W. Carroll Ave., Chicago 12, Ill.
Markem Machine Co., 150 Congress St., Keene, N.H.
Marken Plastic Corp., 2427 E. 55th St., Los Angeles 58, Calif.
Marlo Leather Products Co., 193 Bridge St., Brooklyn 1, N.Y.
Marmyte Co., 500 McKinley Ave., Mundelein, Ill.
Marplex Co., 348 Washington St., El Segundo 6, Calif.
•Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45, Ill.
Maryland Plastics, Inc., 251 E. Central Ave., Federalsburg, Md.
Mason's Art Plastic Sign & Display Co., 1928–7th Ave., Seattle 1, Wash.
Mastercraft Plastics Co., Inc., 95–01 150th St., Jamaica 35, N.Y.
Mastro Plastics Corp., 3040 Webster Ave., New York 67, N.Y.
•Matthews, James H., 3968 Forbes St., Pittsburgh 13, Pa.
•Mayer Refrigerating Engineers, U.S. Rt. 202, Lincoln Park, N.J.
Mayfair Molded Products Corp., 3700 N. Rose St., Franklin Park, Ill.
•Mayflower Electronic Devices, Inc., 20 Industrial Ave., Little Ferry, N.J.
Maynard Plastics Co., 49 Congress St., Salem, Mass.
Mayon Plastics, 415–17th Ave. N., Hopkins, Minn.
McClarin Plastics, R.D. 1, New Oxford, Pa.
McCloskey Varnish Co., 7600 State Rd., Philadelphia 11, Pa.
McCutcheon, George H., 725 N. Western Ave., Los Angeles 29, Calif.
McDonald Mfg. Co., 544 W. 31st St., Los Angeles 11, Calif.
McInnes Steel Co., 3441 E. Main St., Corry, Pa.
•McKesson & Robbins Inc., 155 E. 44th St., New York 16, N.Y.
McMillan Industrial Corp., Brownville Ave., Ipswich, Mass.
Mead Specialties Co., Inc., 4114 N. Knox Ave., Chicago 41, Ill.
Meaker, John W. & Co., 118 W. First St., Hinsdale, Ill.
•Mearl Corp., The, 153 Waverly Pl., New York 14, N.Y.
Mears Kane-Ofeldt, Inc., Div. of S. T. Johnson Co., Church Rd. Bridgeport, Pa.
Mechtronics Co., 423 N. Coulter St., Philadelphia 11, Pa.
Meglino, Nicholas, 241 Van Siclen Ave., Brooklyn, N.Y.
Meiki Co., Ltd., 1,2-chome, Shioiricho, Mizuhoku, Nagoya, Japan
Melamine Plastics Inc., 516 W. 4th St., Winona, Minn.
Meldrum & Fewsmith, Inc., 1220 Huron Rd., Cleveland 15. Ohio
Melin Tool Co., Inc., 3351 W. 140th St., Cleveland 11, Ohio
Merad Laboratories, 1471 N. Cornell Ave., Indianapolis, Ind.
•Merck & Co., Inc., Lincoln Ave., Rahway, N.J.
Mercury Engineering Corp., 2100 N. Farwell Ave., Milwaukee 2, Wis.
Mercury Heat Sealing Equip. Co., 2601-21 N. Howard St., Philadelphia 33, Pa.
•Mercury Industries, Inc., 365 Broadway, Hillsdale, N.J.
Mereen Johnson Machine Co., 4401 N. Lyndale, Minneapolis 12, Minn.
Meriden Molded Plastics, Inc., 25 Mechanic St., Meriden, Conn.
Meridian Plastics, Inc., 8th & Glass Sts., Byesville, Ohio
Merix Chemical Co., 1021 E. 55th St., Chicago 15, Ill.
Merritt-Solem Div., Solem Machine Co., 120 S. Niagara St., Lockport, N.Y.
Meso Plastics Co., 11751 Mississippi Ave., Los Angeles 25, Calif.
Metal Film Co., Inc., 40 Worth St., New York 13, N.Y.
Metal Specialty Co., Este Ave & B. & O. RR., Cincinnati 32, Ohio
•Metal & Thermit Corp., 100 E. 42nd St., New York 17, N.Y.
Metalart Co., The, 166 Valley St., Providence 9, R.I.
Metallic Plastics Corp., 27-10 44th Drive, Long Island City 1, N.Y.
Metallized Products Co., 29 Knight St., Norwalk, Conn.
Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, N.Y.
Metalmasters, Inc., 5292 N. W. Highway, Chicago 30, Ill.
Metalmold Forming Co., 53 Greene St., New York 13, N.Y.
•Metals Disintegrating Co., Inc., Pulverizing Machinery Div., 30 Chatham Rd., Summit, N.J.
Metaplast Process Inc., 34–51 56th St., Woodside 77, N.Y.
Metasap Chemical Co., 1st & Essex Sts., Harrison, N.J.
Metcalf, George T., 31 Canal St., Providence, R.I.
Meyercord Co., 5223 W. Lake St., Chicago 44, Ill.
Mica Corp., The, 4031 Elenda St., Culver City, Calif.
Micarta Div., Westinghouse Electric Corp., Trafford, Pa.
•Michigan Chrome & Chemical Co., 8615 Grinnell Ave., Detroit 13, Mich.
Michigan Fiber-Glas Sales, 18621 E. Nine Mile Rd., E. Detroit, Mich.
Michigan Molded Plastics, Inc., 7931 "G" St., Dexter, Mich.
Michigan Oven Co., 415 Brainard, Detroit 1, Mich.
Michigan Panelyte Molded Plastics, Inc., "G" and Baker Rd., Dexter 1, Mich.
•Michigan Plastic Products, Inc., Robbins Rd., Grand Haven, Mich.
•Mico Instrument Co., 80 Trowgridge St., Cambridge 38, Mass.
Micro Mold, Inc., 185 Pleasant St., Leominster, Mass.
Micro-Wire Stranding Co., 252 Chestnut St., Passaic, N.J.
•Microcell Limited, 56 Kingsway, London, WC2, England
Micron Plastics Corp., 640 Dean St., Brooklyn 38, N.Y.
•Micron Specialties Co., 4253 W. Fullerton Ave., Chicago 39, Ill.
Mid-American Plastics, Inc., 2394 Canal Rd., Cleveland 13, Ohio
Mid States Gummed Paper Co., 2515 S. Damen Ave., Chicago, Ill.
Midland Adhesive & Chemical Corp., 2600 Goodrich, Ferndale 20, Mich.
Midland Coatings, Inc., 13 Main St., N.E., Minneapolis 13, Minn.
•Midland Die & Engraving Co., Div. of Prex Corp., Belmont Ave. & Wolf Rd., Franklin Park, Ill.
Midland Insustrial Finsishes Co., E. Water St., Waukegan, Ill.
Midland Plastics, Inc., 227 N. Water St., Milwaukee 2, Wis.
Midwest Decalcomania Co., 1245 S. State St., Chicago 5, Ill.
•Midwest Molding & Mfg. Co., Gurnee St., Waukegan, Ill.
•Midwest Plastic Products Co., 1801 Chicago Rd., Chicago Heights, Ill.
Midwestern Color Works, 3134 California St., N.E., Minneapolis 13, Minn.
Mildern Mfg. Co., 46 Prospect St., Yonkers, N.Y.
Miller Electric Co., 120 Main St., Pawtucket, R.I.
Miller Engineering Labs., Inc., 51 Walnut St., Winona, Minn.

•Indicates Advertiser.

●Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.
Miller, Frank & Sons, 2250 W. 58th St., Chicago 36, Ill.
Miller, Franklin P. & Sons, Inc., 36 Meadow St., E. Orange, N.J.
Millington Mfg. Co., Warpole St., Upper Sandusky, Ohio
Millsplastic Div., Continental Can Co., 2930 N. Ashland Ave., Chicago 13, Ill.
Milprint, Inc., 4200 N. Holton St., Milwaukee 1, Wis.
●Mimosa Corp., Cardinal Div., Belton, S. C.
●Minerals & Chemicals Corp. of America, Menlo Park, N.J.
Minneapolis Plastic Molders Inc., 6451 Lyndale Ave. S., Minneapolis 6, Minn.
Minneapolis-Honeywell Regulator Co., 2753 4th Ave. S., Minneapolis 8, Minn.
Minnesota Mining & Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.
●Minnesota Plastics Corp., 45 E. Maryland Ave., St. Paul 3, Minn.
Mira Plastics Co., Inc., 50–54 Illinois Ave., Paterson 3, N.J.
Miracle Adhesives Corp., 250 Petit Ave., Bellmore, L.I., N.Y.
Mirror Plastics Co., Inc., 193 William St., New York 38, N.Y.
Miskella Infra-Red Co., The, E. 73rd St. & Grand Ave., Cleveland 4, Ohio
Mitchell Plastics, Inc., Oakdale St., Owosso, Mich.
Mitchell Rand Mfg. Corp., 51 Murray St., New York 7, N.Y.
Mitchell's L. D., Plastic Studio, 501 Pressly St., Pittsburgh 12, Pa.
Mitts and Merrill, 1009 S. Water St., Saginaw, Mich.
Mobay Chemical Co., 1901 S. 2nd St., St. Louis 4, Mo.
Mobile Plastics Div., Carlisle Corp., P.O. Box 72, 1754 Telegraph Rd., Mobile, Ala.
Modern Art Printing Co., 34–36 56th St., Woodside 77, N.Y.
Modern Molders, Inc., North 8th St., Kenilworth, N.J.
Modern Plastic Co., 4641 Pacific Blvd., Los Angeles 58, Calif.
●Modern Plastic Machinery Corp., 15 Union St., Lodi, N.J.
●Modern Plastics, 4000 N.W. 29th St., Miami 42, Fla.
Modern Plastics Corp., 489 N. Shore Dr., Benton Harbor, Mich.
Modern Tool & Die Co., Inc., 11 Spruce St., Leominster, Mass.
●Modigliani Glass Fibers, Inc., 55 W. 42nd St., New York 36, N.Y.
Mojave Die & Engraving, 5729 S. Hoover St., Los Angeles 37, Calif.
Mol-Rex, Div. of American Petrochemical Corp., 3143 California St., N.E., Minneapolis 18, Minn.
Mold Polishing Service, 42 Hamburg Turnpike, Riverdale, N. J.
Mold-Rite Plastics, Inc., 502 North First St., Cambridge, Ohio
Moldcraft Inc., 1505 W. 41st St., Baltimore 11, Md.
Molded Fiber Glass Body Co., 4601 Benefit Ave., Ashtabula, Ohio
Molded Fiber Glass Sheet Co., Ashtabula, Ohio
Molded Fiberglass Co., 4601 Benefit Ave., Ashtabula, Ohio
Molded Fiberglass Tray Co., E. Erie St., Linesville, Pa.
Molded Industrial Plastics, Inc., 150–45 12th Ave., Whitestone 57, N.Y.
Molded Insulation Co., 335 E. Price St., Philadelphia 44, Pa.
Molded Products Co., Inc., 2820 N. Sylvania, Ft. Worth 11, Texas
●Molded Products, Div. of Admiral Corp., Washington S. & Creamery Rds., West Chicago, Ill.
Molded Resin Fiber Co., 4401 Benefit Ave., Ashtabula, Ohio
Molding Corp. of America, Inc., 58 Weybosset St., Providence, R.I.
Moldmakers, Inc., 323 W. 5th St., Peru, Ind.
Moldrite Products Co., The, 171–8th St., Providence 6, R.I.
Molex Products Co., 9515 Southview Ave., Brookfield, Ill.
Monoplastics, Inc., Route 7, Georgetown, Conn.
Monite Waterproof Glue Co., 1113 Monite Bldg., Minneapolis 11, Minn.
●Mono-Sol Corp., 407 County Line Rd., Gary, Ind.
Monogram of Calif., 2500 18th St., San Francisco 10, Calif.
Monrovia Plastic Co., Inc., 904 South Alta Vista Ave., Monrovia, Calif.
●Monsanto Chemical Co., Organic Chemicals Div., 800 N. 12th St., St. Louis 18, Mo.
●Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.
●Monsanto-Kasei Chemical Co., No. 4,2 Chome, Marunouchi, Tokyo, Japan
Montan Export, Inc., 17 Battery Pl., New York 4, N.Y.
Montecantini, Via Turati 18, Milano, Italy
Montrose Chemical Co., 120 Lister Ave., Newark 5, N.J.
Moore Plastics, 330 Melrose Pl. San Antonio 9, Texas
Moore, Samuel & Co., Main & Orchard Sts., Mantua, Ohio
●Morat Gravure Corp., Holyoke, Mass.
Morgan Plastics, 116–16th Ave. N., Nashville, Tenn.
●Morningstar Corp., The, 156 Sixth St., Cambridge 42, Mass.
Morningstar Nicol, Inc., Paisley Products Div., 630 W. 51st St., New York 19, N.Y.
Morrell, George Corp., 1355 W. Sherman Ave., Muskegon Heights, Mich.
Morse Mfg. Co., Inc., 727 W. Manlius St., E. Syracuse, N.Y.
Morton-Withers Chemical Co., 2110 High Point Rd., Greensboro, N.C.
●Mosinee Paper Mills Co., Mosinee, Wis.
●Moslo Machinery Co., 2443 Prospect Ave., Cleveland 15, Ohio
Motson, Frank J., Co., 1717 Bethlehem Pike, Flourtown, Pa.
Moulding Corp. of America, 53 Crosby St., New York 12, N.Y.
Mount Hope Machinery Co., 15 Fifth St., Taunton, Mass
Mt. Vernon Mills, Mercantile Trust Bldg., Baltimore, Md.,
Mowat, Geo. R., 24 W. 40th St., New York, N.Y.
●Muehlstein, H. & Co., Inc., 60 E. 42nd St., New York 17, N.Y.
Mueller, Ernest, 125 N. Detroit St., Los Angeles 36, Calif.
Mullican Co., The, 310 W. Liberty St., Louisville 2, Ky.
Multi-Craft, Inc., 6105 N.E. Union Ave., Portland 11, Ore.
Multiplastics, Div., Curd Enterprises, Inc., 770 Factory Rd., Addison, Ill.
Multiplastics, Inc., 4155 S. Cherry St., Wallingford, Conn.
Mundane Co., The, Verplanck, N.Y.
Munray Products, Inc., 12400 Crossbrun Ave., Cleveland 11, Ohio
Munton Mfg. Co., 9400 Belmont Ave., Franklin Park, Ill.
Murdoch, Colin D., 718 First Ave., San Leandro, Calif.
Murray Corp., 11 W. Pennsylvania Ave., Towson 4, Md.
Murray Plastics Co., 26 Cottage St., Poughkeepsie, N.Y.
Murray Products, Inc., Div. of Poly-Cycle Products Co., 12500 Crossburn Ave., Cleveland 11, Ohio
Mutual Plastic Mold Co., 5141 Firestone Pl., South Gate, Calif.
●Mycalex Corp. of America, 125 Clifton Blvd., Clifton, N.J.
Myler Plastics Corp., 92 Bishop St., Jersey City 4, N.J.

N

●NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass.
Naken, William, 1107 S. Burnside Ave., Los Angeles 19, Calif.
Nalle Plastics, Inc., 108 W. 2nd St., Austin 1, Texas
Name Plate Products Co., Longshore & Vandike Sts., Philadelphia, Pa.
Narmco Resins & Coatings, Co., 600 Victoria St., Costa Mesa, Calif.
Nas-Kay Industries, S.E. Corner 55th & Wyaulsing Ave., Philadelphia, Pa.
Nash, Ben, 15 Gramercy Park, New York 3, N.Y.
Nash Engineering Co., The, S. Norwalk, Conn.
●Nash, J. M. Co., 2360 N. 30th St., Milwaukee 45, Wis.
National Adhesives Div., National Starch Products, Inc., 270 Madison Ave., New York 16, N.Y.
●National Aniline Div., Allied Chem. & Dye Corp., 40 Rector St., New York 6, N.Y.
National Automatic Tool Co., Inc., S. 7th & North Sts., Richmond, Ind.
National Automotive Fibres Inc., 1851 E. State St., Trenton, N.J.
National Casein Co., 601 W. 80th, Chicago 20, Ill.
National Cylinder Gas Co., Girdler Co., The, Div., Thermix Div., 224 E. Broadway, Louisville, Ky.
●National Distillers Products Corp., United States Industrial Chemicals Co., Div., 120 Broadway, New York 5, N.Y.
National Electrical Mfrs. Assoc., 155 E. 44th St., New York 17, N.Y.
National Lead Co., 111 Broadway, New York 6, N.Y.
National Lead Co., Research Labs., 105 York St., Bklyn, N.Y.
National Lock Co., 1902 7th St., Rockford, Ill.
National Petro Chemicals Corp., 120 Broadway, New York, N.Y.
National Plainfield Corp., Plainfield, Conn.
●National Plastic Products Co., The, Odenton, Md.
National Plastics, Inc., 2326–2330 McCalla Ave., Knoxville, Tenn.
●National Polymer Products, Inc., 125 N. 4th St., Reading, Pa.
National Research Corp., 160 Charlemont, Newton Highlands 61, Mass.
●National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio
National Vacuum Molding Corp., 923 Old Nepperhan Ave., Yonkers, N.Y.

●Indicates Advertiser.

National Vacuum Platers, Inc., 2635 E. Hagert St., Philadelphia 25, Pa.
•National Vulcanized Fibre Co., Maryland Ave. & Beech St., Wilmington, Del.
•National Vulcanized Fiber Co., Fiber Specialty Mfg. Co. Div., 1718 Girard Trust Bldg., Phila. 2, Pa.
Natvar Corp., 211 Randolph Ave., Woodbridge, N.J.
•Naugatuck Chemical, Div. United States Rubber Co., 203 Elm St., Naugatuck, Conn.
Navarm Chemical Co., 5318 Atlantic Blvd., Maywood, Calif.
Naz-Dar Co., 461 Milwaukee Ave., Chicago 10, Ill.
Nebraska Plastics Inc., Cozad, Nebr.
•Negri, Bossi & Co., Corso Magenta 44, Milano, Italy
Neptune Meter Co., 19 W. 50th St., New York 20, N.Y.
Nering's Plastics, 3982 Broadway, Gary, Ind.
Nesbit Industries, Inc., 1823 Milwaukee Ave., Chicago 47, Ill.
Nettleton, W. O. & Associates, 54 Water St., Guilford, Conn.
Neville Chemical Co., Neville Island Pittsburgh 25, Pa.
New England Engineering & Mfg. Co., 6 Baxter St., Worcester 2, Mass.
New England Laboratories, County Rd., Ipswich, Mass.
New England Lacquer Co., King Philip Rd., Providence 14, R.I.
•New England Laminates Co., Inc., 16 Dyke Lane, Stamford, Conn.
New England Plastics Corp., 169 Elm St., Waltham 54, Mass.
New England Spectrochemical Labs., County Rd., Ipswich, Mass.
New England Tool Co., 64 Floral St., Taunton, Mass.
•New Hermes Engraving Machine Corp., 13–19 University Pl., New York 3, N.Y.
New Jersey Pulverizing Co., 450 7th Ave., New York, N.Y.
New Jersey Zinc Co., The, 160 Front St., New York 38, N.Y.
New Plastic Corp., 1026 N. Sycamore Ave., Los Angeles 38, Calif.
New York Quinine & Chemical Works, Inc., The, 50 Church St., New York 8, N.Y.
•Newark Die Co., 24 Scott St., Newark, N.J.
•Newark Die Hobbing & Casting Co., 20 Scott St., Newark 2, N.J.
Newark Paraffine & Parchment Paper Co., 50 Jelliff Ave., Newark 8, N.J.
Newark Plastics Printers Co., 27 E. 33rd St., Paterson, N.J.
•Newbury Industries, 2030 Munn Rd., Newbury, Ohio
Newcraft Mfg. Corp., 3–01 27th Ave., Long Island City 2, N.Y.
Newport Industries, Inc., 230 Park Ave., New York 17, N.Y.
Newport Plastics Corp., North Ave., Newport, N.J.
Niagara Alkali Co., 60 E. 42nd St., New York 17, N.Y.
•Niagara Machine & Tool Works, 637–697 Northland Ave., Buffalo 11, N.Y.
Niagara Plastics Co., Inc., Rd. #3, Edinboro Rd., Erie, Pa.
Nichols Products Co., 325 W. Main St., Moorestown, N.J.
Niles Corp., 2827 Dixie Way North, South Bend 17, Ind.
Niles-Bement-Pond Co., Pratt & Whitney Div., Charter Oak Blvd., West Hartford 1, Conn.
•Nixon Nitration Works, Nixon, N.J.
Nopco Chemical Co., Stier St., Harrison, N.J.
Norco Plastic Inc., 3888 N. Fratney St., Milwaukee 12, Wis.
Nord Corp., 18 Spruce St., Nutley 10, N.J.
Nordic Plastics Corp., 383 Douglass St., B'klyn 17, N.Y.
Norman, Emile, Big Sur, Calif.
North American Asbestos Corp., 141 W. Jackson Blvd., Chicago 4, Ill.
North American Electric Lamp Co., 1520 N. 13th St., St. Louis 6, Mo.
North East Laminates, Inc., 51 Osgood St., Methuen, Mass.
Northeastern Plastics Inc., 215 A St., Boston 10, Mass.
•Northern Industrial Chemical Co., 7 Elkins St., Boston 27, Mass
Northern Plastics Corp., 2nd Market St., La Crosse, Wis.
Northwest Plastic Industries, 2040–15th Ave., Seattle 4, Wash.
Northwest Plastics, Inc., 65 E. Plato, St. Paul 1, Minn.
Norton, Arthur J., R.F.D. 1, Box 581, Vashon, Wash.
Norton Co., 1 New Bond St., Worcester 6, Mass.
•Norton Laboratories, Inc., 520 Mill St., Lockport, N.Y.
Nosco Plastics, Inc., 1701 Gaskell Ave., Erie, Pa.
Nova Chemical Corp., 153 Waverly Pl., New York 14, N.Y.
Novelty Bias Binding Co., 181 Spencer Ave., Chelsea 50, Mass.
Nu-Engineering, Inc., 1515 Bonner Ave., Ferndale 20, Mich.
Nu-Way Sash & Screen Mfg. Co., 20455 Van Born Rd., Dearborn, Mich.
Numa Plastics Corp., 221 E. 38th St., New York 16, N.Y.
Nuodex Products Co., Inc., 342 Madison Ave., New York 17, N.Y.
Nureco, Inc., 1100 Pontiac Ave., Cranston 10, R.I.
•Nutmeg Chrome Corp., 111 Vanderbilt Ave., W. Hartford, Conn.
Nytef Plastics Inc., 214 Front St., S. Plainfield, N.J.

•Indicates Advertiser.

O

OMCO Mold Co., Drawer 68, Fremont, Ind.
Oak Engineering Co., Inc., 110 Monmouth St., Gloucester City, N.J.
Oakite Products, Inc., 46D Rector St., New York 6, N.Y.
Oakley Die & Mfg. Co., Inc., 4426 Brazee St., Cincinnati 9, Ohio
O'Connell, Daniel C. Assoc., 70 E. 45th St., New York 17, N.Y.
Ohio Adhesives Corp., Maple Ave. Ext., New Philadelphia, Ohio
Ohio Sealer & Chemical Corp., P.O. Box 95, Brookville, Ohio
•Ohio-Apex Div., F.M.C., Nitro, W. Va.
Oilgear Co., The, 1560 W. Pierce, Milwaukee 4, Wis.
Olin Mathieson Chemical Corp., Film Div., 655 Madison Ave., New York 21, N.Y.
Oliver Corp., A. B. Farquhar, Div., 142 N. Duke St., York, Pa.
Olsen, Tinius, Testing Machine Co., Easton Rd., Willow Grove, Pa.
•Olsenmark Corp., 124 White St., New York 13, N.Y.
Olympic Plastics Co., Inc., 3471 S. La Cienega Blvd., Los Angeles 16, Calif.
Omaha Plastics Co., 1470 S. 16th St., Omaha 8, Nebr.
Omco Plastic Mold, Freemont, Ind.
•Omni Products Corp., 460 Fourth Ave., New York 16, N.Y.
Omohundro Co., Paul, 15506 S. Lakewood Blvd., P.O. B. 696, Paramount, Calif.
O'Neil-Irwin Mfg. Co., 679–8th Ave., Lake City, Minn.
Onsrud Machine Works, Inc., 3910 W. Palmer St., Chicago 47, Ill.
Ontario Plastics Inc., 2503 Dewey Ave., Rochester 13, N.Y.
Onyx Oil & Chemical Co., Warren & Morris Sts., Jersey City, N.J.
Onyx Oils & Resins, Inc., 125 Broad St., New York 4, N.Y.
Oppenheimer Corp., 578 Exchange St., Buffalo 10, N.Y.
Optical Film Engineering Co., 2731–37 N. 6th St., Phila. 33, Pa.
•Orange Products, Inc., 554 Mitchell, Orange, N.J.
Orange Roller Bearing Co., Inc., 558 Main St., Orange, N.J.
Orchard Industries, Inc., 701 W. State St., Hastings, Mich.
Original Plastics, Inc., 529–531 54th St., West New York, N.J.
Orma Corp., 10400 Tucker St., Beltsville, Md.
Ormond Mfg. Co., Inc., 3325 Hudson Ave., Union City, N.J.
Orna Plastics Co., 8583 Venice Blvd., Los Angeles 34, Calif.
Oronite Chemical Co., 200 Bush St., San Francisco 4, Calif.
Osborn, C. J. Co., 1301 W. Blancke St., Linden, N.J.
O'Sullivan Rubber Corp., P.O. Box 603, Valley Pike, Winchester, Va.
Ott, J. M. P., Mfg. Co., Inc., 87 Sabin St., Pawtucket, R.I.
Owens-Corning Fiberglas Corp., 598 Madison Ave., New York 22, N.Y.
Owens-Corning Fiberglas Corp., Textile Products Div., 16 E. 56th St., New York 22, N.Y.
•Owens-Illinois Co., Closure & Plastics Div., P.O. Box 1035–1036, Toledo 1, Ohio

P

P & H Enterprises, 121 W. 64th St., New York 23, N.Y.
P. M. S. Co., The, 1071 Power Ave., Cleveland 14, Ohio
P-V-A- Industries, 224 E. 38th St., New York 16, N.Y.
Pace, F. D. Co., 69-73 Scribner N. W., Grand Rapids 4, Mich.
Pacific Plasti-Fab Corp., 1001 Varian St., San Carlos, Calif.
Pacific Plastics Co., 707 Lander St., Seattle 4, Wash.
Pacific Plastics Co., Inc., 2724-6th Pl., Seattle, Wash.
Package Machinery Co., E. Longmeadow, Mass.
Pacific Plasti-Fab Corp., 1001 Varian St., San Carlos, Calif.
Packless Metal Hose, Inc., 730 S. Columbus Ave., Mt. Vernon, N.Y.
Paisley Products, Inc., Div., Morningstar Nicol, Inc., 630 W. 51st St., New York 19, N.Y.
Palfy Die-Mold Co., The, 2900 Bradwell Ave., Cleveland 9, Ohio
Palmer, Homer W. & Co., 515 N. Halstead St., Chicago 22, Ill.

Palmer Scott & Co., Inc., Foot of Logan, New Bedford, Mass.
Palnut Co., The, 33 Glen Rd., Mountainside, N.J.
Pan American Chemicals Corp., 555 5th Ave., New York 17, N.Y.
Pan Laminates, Inc., 441 Madison Ave., New York 22, N.Y.
Panama-Beaver, 2633 Touhy Ave., Chicago, Ill.
Panelyte Div., St. Regis Paper Co., 150 E. 42nd St., New York, N.Y.
Pangborn Corp., 640 Pangborn Blvd., Hagerstown, Md.
Pantasote Co., The, 415 Madison Ave., New York 17, N.Y.
●Pantex Manufacturing Corp., 521 Roosevelt Ave., Central Falls, R.I.
Paper Converting Machine Co., 601 Harvey St., Green Bay, Wis.
Paper Products Development Corp., 453 W. 17th St., New York, N.Y.
Paragon Imprinting Co., 53 E. 10th St., New York 3, N.Y.
●Paragon Molding Co., 2412 Norwood St., Melrose Pk., Ill.
Paragon Plastic Corp., 295 Lafayette St., New York, N.Y.
Parcher, James H. & Associates, 219 North Broad St., Phila. 7, Pa.
Parcloid Chemical Co., 31 Cross Ave., Mildand Park, N.J.
Park Plastics Co., 940 Park Ave., Linden, N.J.
Parke, Norman Co., 7 Springfield Ave., Chicopee, Mass.
Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio
Parker-Hartford Corp., The, 650 Franklin Ave., Hartford 1, Conn.
Parker Mfg. Co., 1466 F., San Diego 2, Calif.
●Parker-Kalon Div., General American Transportation Corp., 200 Varick St., New York 14, N.Y.
*Parker Stamp Works, Inc., The, 650 Franklin Ave., Hartford 14, Conn.
Parkway Plastics Inc., Stelton Rd., Newmarket, N.J.
●Parkwood Laminates, Inc., 24 Water St., Wakefield, Mass.
Pasadena Hydraulics, Inc., 1433 Lidcombe, El Monte, Calif.
Patent Button Co. of Tenn., Inc., The, 2200 Century St., Knoxville, Tenn.
Patent Chemicals Inc., 335 McLean Blvd., Paterson, N.J.
Paterson Parchment Paper Co., Bristol, Pa.
Pathway Plastic Corp., 133 S. Terrace Ave., Mt. Vernon, N.Y.
Patron Transmission Co., Inc., 129 Grand St., New York 13, N.Y.
Patterson Foundry & Machine Co., 1290 St. George St., E. Liverpool, Ohio
Patzig Testing Laboratories, 2215 Ingersoll Ave., Des Moines 12, Iowa
Paxton Kellering, 57-17 79th Ave., Glendale 27, N.Y.
Pearson-Berlinghof, Inc., 18 North State St., Newtown, Pa.
Peat Mfg. Corp., 10700 E. Firestone Blvd., Norwalk, Calif.
●Peco Machinery Sales (Westminster) Ltd., 28 Victoria St., London S.W. 1, England
Peerless Chemical Corp., Verplanck, N.Y.
Peerless Mfg. & Distributing Co., Inc., 1315 Ellis St., Waukesha, Wis.
Peerless Molded Plastics, Inc., 401 Hamilton St., Toledo 2, Ohio
●Peerless Roll Leaf Co., Inc., 4511 New York Ave., Union City, N.J.
Pelican Plastics, Inc., Box 120, Homer, La.
Pellon Corp., 350-5th Ave., New York 1, N.Y.
Pelron Corp., 7847 W. 47th St., Lyons, Ill.
Pelsen Tool & Die Co., 25 Sterling St., Clinton, Mass.
●Penn-Plastics Corp., Tyson & Fairhill Sts., Glenside, Pa.
Pennsylvania Color & Chemical Co., Pine Run Rd., Doylestown, Pa.
Pennsylvania Crusher Co., Room 1718, Liberty Trust Bldg., W. Chester, Pa.
Pennsylvania Industrial Chemical Corp., 120 State St., Clairton, Pa.
Pennsylvania Plastic Co., 3231 Spring Garden Ave., Pittsburgh 12, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., 2686 Lisbon Rd., Cleveland 4, Ohio
Pennsylvania Salt Mfg. Co., Industrial Div., 3 Penn Center Plaza, Philadelphia 2, Pa.
Penola Oil Co., 14300 McNichols Rd., W., Detroit 35, Mich.
Peoria Plastic Co., 215 Taylor Ave., E. Peoria, Ill.
Pereles Bros., Inc., 5840-50 N. 60th St., Milwaukee 15, Wis.
Perfex Plastics, Inc., 2632 S. Dearborn, Chicago 28, Ill.
Perforated Specialties, 351 W. 35th St., New York 1, N. Y.
●Perforating Industries, Inc., 310 W. Westfield Ave., Roselle Park, N. J.
Perkins Glue Co., Lansdale, Pa.
Permacel Tape Corp., U. S. Highway #1, New Brunswick, N.J.
Perma Seal Plastic Products Co., 366 Wacouta St., St. Paul 1, Minn.
Permanent Label Corp., 49 Ackerman St., Bloomfield, N.J.
●Perry Plastics, Inc., 3409 W. 14th St., Erie, Pa.
Perrysburg Laboratories, Inc., 125 W. Third St., Perrysburg, Ohio
●Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Rd., Bedford, Ohio
●Peters Chemical Mfg. Co., 3623 Lake St., Melrose Park, Ill.
●Peterson, A. W. & Sons Die Co., 131 Prince St., New York 12, N.Y.
Petro-Tex Chem. Corp., La Porte Rd., Houston 1, Texas
Petroleum Chemicals, Inc., P.O. Box 6, New Orleans 6, La.
Petroleum Specialties, Inc., 205 E. 42nd St., New York 17, N.Y.
Pettibone Mulliken Corp., Beardsley & Piper Div., 2424 N. Cicero Ave., Chicago 39, Ill.
Pfizer, Chas. & Co., Inc., 630 Flushing Ave., B'klyn 6, N.Y.
Phelps Mfg. Co., The, Box 542, Westport, Conn.
Phen-Treis, Inc., 15 Franklin Pl., Rutherford, N.J.
Philadelphia Quartz Co., 1146 E. Public Ledger Bldg, Phila, 6, Pa.
●Phillips Chemical Co., Bartlesville, Okla.
●Phillips Petroleum Co., Market Development Div., Bartlesville, Okla.
Phoenix Plastics Corp., Main St., Clinton, Mass.
Pierce & Stevens Chemical Corp., 710 Ohio St., Buffalo 3, N.Y.
Pierce Machine Tool Co., 1100 E. 31st St., LaGrange Park, Ill.
Pikes Peak Plastics, Inc., 109 S. Conejas, Colo. Springs, Colo.
Pine-Wood Plastic Co., Inc., 245 Sixth St., Cambridge, Mass.
Pioneer Industries Inc., Div. Pioneer Latex & Chemical Co., Lincoln Blvd., Middlesex, N.J.
Pioneer Lacquer Corp., McCarthy Ave., Cherry Valley, Mass.
Pioneer Latex & Chemical Co., & Pioneer Industries, Inc., (Affiliate), Lincoln Blvd., Middlesex, N.J.
Pioneer Plastics, Box 641, Far Hills Branch, Dayton 9, Ohio
Pioneer Plastics Corp., 28 Goodhue, Salem, Mass.
Pioneer Scientific Corp., 161 Great Neck Rd., Great Neck, N.Y.
Pioneer Valley Plastics Co., 7 Springfield St., Chicopee, Mass.
Pirelli S.P.A., Viale Abruzzi, 94 Milano, Italy
Pitman Plastic Products, Inc., 55 Commercial Ave., Pitman, N.J.
Pitt-Consol Chemical Co., 191 Doremus Ave., Newark 5, N.J.
●Pittsburgh Coke & Chemical, 2000 Grant Bldg., Pittsburgh 19, Pa.
Pittsburgh Plastics Corp., Rt. 168, W. Pittsburgh, Pa.
●Pittsburgh Plate Glass Co., Columbia-Southern Chem. Corp., One Gateway Center, Pittsburgh 22, Pa.
●Pittsburgh Plate Glass Co., Fiber Glass Div., One Gateway Center, Pittsburgh 22, Pa.
●Pittsburgh Plate Glass Co., Selectron Resins Div., One Gateway Center, Pittsburgh 22, Pa.
Plandex Corp., Chestnut & Acorn Lane, Downingtown, Pa.
Planet Plating Co., Inc., 494 Morgan Ave., B'klyn 22, N.Y.
Plano Molding Co., 1135 Center Ave., Plano Ill.
Plant Plastics, Inc., 417 Church Ave., S. W., P.O. Box 1342, Knoxville, Tenn.
Plas-Steel Products, Inc., 309 Tennessee, Walkertown, Ind.
Plas-Tex Corp., The, 2525 Military Ave., Los Angeles 64, Calif.
Plas-Ties Co., 624 Poinsettia St., Santa Ana, Calif.
●Plas Tube, Inc., 20 Fahey St., Springfield, Conn.
Plaskolite, Inc., 222 Neilston St., Columbus, Ohio
●Plaskon, Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y.
Plast-Ad Mfg. Co., 222 N. Michigan St., S. Bend 22, Ind.
Plast-O-Matic Corp., 37 Spruce St., Leominster, Mass.
Plastal Specialties Co., 116 W. Denny Way, Seattle 99, Wash.
Plastene Corp., 712 Chrysler Bldg., 405 Lexington Ave., New York, N.Y.
Plastex Co., The, Div. of The Zimmerman Co., 3232 Cleveland Ave., Columbus 3, Ohio
Plastex Laminating, Inc., Box 642, Miami Springs, Fla.
Plastex Process Co., 230 W. Passaic St., Maywood, N.J.
Plasti-Chem. Corp, 5725 S. Dixie (U.S. 1) Miami 43, Fla.
Plasti-Line Inc., Dutch Valley Rd. at Broadway, Knoxville 18, Tenn.
Plasti-Vue, 150-38-12th Ave., Whitestone 57, L.I., N.Y.
Plastic Academy Products Co., 345 Central St., Leominster, Mass.

●Indicates Advertiser.

Plastic Age Sales Co., 651 Arroyo Ave., San Fernando, Calif.
Plastic Art Decorating Co., 68 Freeman St., Brooklyn 22, N.Y.
Plastic Artisans, Inc., Dock St. & Martin Pl., Port Chester, N.Y.
Plastic Box Co., 2500 18th St., San Francisco 10, Calif.
Plastic Calendering Corp., 40 East 34 St., New York
Plastic Center, 127 N. Water St., Rochester 4, N. Y.
Plastic Coating Co., Holyoke, Massachusetts
Plastic Creators, Inc., 16 Industrial Ave., Little Ferry, N.J.
Plastic Embedments Co., 74 Falmouth St., Attleboro, Mass.
Plastic Engineering Co., Dunnell Lane, Pawtucket, R.I.
Plastic Engineering Co. of Tulsa, 3128 E. Admiral Pl., Tulsa 10, Okla.
Plastic Enterprises, 124-14 22nd Ave., College Pt., N.Y.
Plastic Fabricating Co., Inc., 722 E. 9th St., Wichita 5, Kansas
Plastic Fabricators, 44 Murray St., New York 7, N.Y.
Plastic Film Corp., Plainfield, Conn.
Plastic Forming Equipment, 333 N. Michigan Ave., Chicago, Ill.
Plastic Glass Corp., 33 Ave. "P," Newark 5, N.J.
Plastic Industrial Products, Inc., 363 Highland Ave., Somerville 44, Mass.
Plastic Industries, Inc., Pope St., Athens, Tenn.
*Plastic Inlays, Inc., 282 Broad St., Summit, N.J.
Plastic Innovations, Inc., 185 Riverdale Ave., Yonkers, N.Y.
Plastic Laminating Co., Wallingford Rd., S. of Balto Pike, Swarthmore, Pa.
Plastic Laminating Corp., 2087 Springfield Ave., Vaux Hall, N.J.
Plastic Lining Corp., 914 S. Wabash Ave., Chicago 5, Ill.
Plastic Masters Inc., U.S. 12 West, New Buffalo, Mich.
Plastic Materials, Inc., New South Rd., Hicksville, N.J.
Plastic Materials, Inc., 589 Main St., Westbury, N.Y.
Plastic Model Engineering, 14530 Arminta St., Van Nuys, Calif.
Plastic Mold Co., 3574 Fruitland Ave., Maywood, Calif.
Plastic Mold & Die Co., 308 S. 3rd St., Darby, Pa.
Plastic Mold & Tool Co., 7347 State Rd., Phila. 35, Pa.
Plastic Mold Tool & Die Co., 1 Maple St., E. Rutherford, N.J.
•**Plastic Molded Products Co.**, 6044 N. Pulaski Rd., Chicago 30, Ill.
•**Plastic Molders Supply Co., Inc.**, 74 South Ave., Fanwood, N. J.
•**Plastic Molding Corp.**, Sandy Hook, Conn.
Plastic Molding Powders, Inc., 2004 McDonald Ave., Brooklyn 23, New York
Plastic Moldings Corp., 859 Hathaway St., Cincinnati 3, Ohio
Plastic Paper Co., 5365 Poplar Blvd., Los Angeles 32, Calif.
Plastic Parts Corp., 2425 Ryan Rd., Maumee, Ohio
Plastic Pigment Co., Inc., 5-33 48th Ave., Long Island City 1, N.Y.
Plastic Process Co., Inc., Div. Monadnock Mills, 11200 Hindry Ave., Los Angeles 45, Calif.
Plastic Productions, 875 Washington St., Canton, Mass.
Plastic Products Corp., 24001 Aurora Rd., Bedford Heights, Ohio
Plastic Products, Inc., Pine St., S. Norwalk, Conn.
•**Plastic Research Products**, 200 Beech St., Urbana, Ohio
Plastic Rotocast Co., 703 S. La Salle St., Chicago 5, Ill.
Plastic Sales Corp., 1116 Central Ave., Charleston, W. Va.
Plastic Service Inc., 1145 W. Fulton St., Chicago 7, Ill.
Plastic Service Corp., 318 E. 32nd St., New York 16, N.Y.
Plastic Specialty Products, 36 Clark St., Warren, Pa.
Plastic Studio, 501 Pressley St., Pittsburgh, Pa.
Plastic Suppliers & Mfgrs., 1635 Scenic Hwy., Baton Rouge, La.
Plastic Tooling Aids Laboratory, 475 Madison Ave., Bridgeport 4, Conn.
Plastic Toys Corp., Byesville, Ohio
Plastic Welding Corp., 780 Frelinghuysen Ave., Newark 12, N.J.
Plasticles Corp., 14590 Schaefer Rd. Detroit 8, Mich.
Plasticraft Mfg. Co., 287 Laurel Ave., Kearny, N.J.
•**Plasticrafters, Inc.**, 1829 S. 55th Ave., Chicago 50, Ill.
Plasticrafts, Inc., 2800 N. Speer Blvd., Denver 11, Colo.
Plasticraft Mfg. Co., 287 Laurel Ave., Kearny, N.J.
Plastics Associates, P.O. Box 869, Pasadena 20, Calif.
Plastics By Chapman, 1952 University Ave., Berkeley 4, Calif.
Plastics Center of Texas, 317 Nogalitos St., San Antonio 2, Tex.
•**Plastics Color Co.**, 22 Commerce St., Chatham, Pa.
Plastics Consultant Service, 155 E. 40th St., New York 16, N.Y.
Plastics Development Service, P.O. Box 869, Pasadena, Calif.
Plastics Engineering, 2113 E. Sergeant St., Phila. 25, Pa.
•**Plastics Engineering Co.**, 1607 Geele Ave., Sheboygan, Wis.
Plastics, Inc., 224 Ryan Ave., St. Paul 2, Minn.
Plastics, Inc., 304 W. Walnut St., Pasadena 3, Calif.
Plastics, Laminates & Fabrics, Inc., 4640 W. Fullerton, Chicago 39, Ill.
Plastics Mfg., Inc., 484 Thomas St., Orange, N.J.
Plastics Materials Corp., xxx S. Windham, Me.
•**Plastics Stamping & Molding Corp.**, 2216 W. Armitage Ave., Chicago, Ill.
Plastics-Tool Eng. Co., 70 Bridge St., Hackensack, N.J.
Plastiline, Inc., 2 Intervale St., White Plains, N.Y.
Plastimayd Products Corp., 931 S.E. 6th Ave., Portland 14, Ore.
Plastimold Corp., 61 Union St., Attleboro, Mass.
Plastipipe, Inc., 5544 W. 104th St., Los Angeles 45, Calff.
Plastiplate Co., Inc., 7-9 Homes Ave., South River, N.J.
Plastofilm, Inc., 916 W. Union Ave., Wheaton, Ill.
Plast-O-Matic Corp., 37 Spruce St., Leominster, Mass.
Plastray Corp., 823 Fisher Bldg., Detroit 2, Mich.
Plastron Specialties, Inc., 786 Ceres Ave., Los Angeles 21, Calif.
Plastylite Corp., 333 North Drive, N. Plainfield, N.J.
•**Plating Engineering Co.**, 1928 South 62nd St., Milwaukee 14, Wis.
Plax Corp., P.O. Box 1019, Hartford, Conn.
•**Plaxall, Inc.**, 5-26 46th Ave., L.I.C., N.Y.
Plectron Corp., Box 7, Overton, Neb.
Plexolite Corp. of California, 2051 East Maple, El Segundo, Calif.
Plexon Corp., 104 S. Hudson, Greenville, S.C.
Plicose Mfg. Corp., 71-77 Box St., B'klyn 22, N.Y.
Pluess-Staufer (North American) Inc., 82 Beaver St., New York, N.Y.
*Plumb Chemical Corp., 4837 James St., Phil. 37, Pa.
•**Plura Plastics Co.**, 17-21 Newark Way, Maplewood, N.J.
•**Plymouth Fibers**, 195 Plymouth Ave., Brooklyn, N.Y.
Plymouth Industrial Products, Inc., 502 Indiana Ave., Sheboygan, Wis.
Pneumatic Scale Corp., 65 Newport Ave., N. Quincy 71, Mass.
Podt, Messrs. M. J., Slikkerveer, Holland
Poinsettia Co., Inc., 112 Cedar Ave., Pitman 7, N.J.
Polamold Products, P.O. Box 126, Springfield, Ohio
Poliner, William, 1300 Alicia Ave., W. Englewood, N.J.
Pollack Industrial Corp., Ross & Roberts Co. Div., 1299 W. Broad St., Stratford, Conn.
Polo Plastics Co., 1718 N. 1st St., Milwaukee 12, Wis.
Poly Cyclo Products Co., 12400 Cressburn Ave., Cleveland, Ohio
Poly Plastic Products, Inc., 2 Fourth Ave., Paterson 4, N.J.
Poly Resins, 11661 Wicks St., Sun Valley, Calif.
Poly-Cell Plastics Co., Smithtown, New York
Poly-Cycle Products Co., Murray Products Inc., Div., 12500 Cressburn Ave., Cleveland 11, Ohio
Poly-Fiber, Inc., 4545 Brazil St., Los Angeles 39, Calif.
Polycast Corp., The, 69 Southfield Ave., Stamford, Conn.
•**Polychemical Div. of E. I. du Pont de Nemours & Co., Inc.**, Wilmington, Del.
•**Polygon Plastics Co.**, Roosevelt Rd., Walkerton, Inc.
Polyken Products Dept., 222 W. Adams, Chicago 6, Ill.
Polykote, Inc., 877 Addison Rd., Cleveland 3, Ohio
Polymer Chemical Co., 5920 Carthage Ave., Cincinnati 12, Ohio
•**Polymer Chemicals Div., W. R. Grace & Co.**, 3 Hanover Sq., New York 5, N.Y.
•**Polymer Corp. of Pa., The**, 2140 Fairmont Ave., Reading, Pa.
Polymer Engineering Corp., 100 Houston Club Building, Houston 2, Texas
Polymer Industries, Inc., Springdale, Conn.
•**Polymer Process, Inc.**, P.O. Box 276, Reading, Pa.
Polymold Plastics, Inc., 3417 N. Western Ave., Chicago 18, Ill.
•**Polypenco, Inc.**, 2150 Fairmont Ave., Reading, Pa.

•Indicates Advertiser.

Polyphane Corp., 151 Mt. Vernon Ave., Mt. Vernon, N.Y.
●Polyplastex United, Inc., 870 Springfield Rd., Union, N.J.
Polyply Co., 4620 Santa Fe, San Diego 9, Calif.
Polyrex Co., S. Columbia St. & Railroad, Woodbury, N.J.
●Port Erie Plastics Corp., 561 E. 18th St., Erie, Pa.
●Portage Plastics Co., 1325 Adams St., Portage, Wis.
●Porter, H. K. Co., Inc., Watson-Stillman Co., Div., 109 Aldene Rd., Roselle, N.J.
Porter-Cable Machine Co., 1714 N. Salina St., Syracuse 8, N.Y.
Portz Plastics & Fibre Co., 411 North 3rd St., Milwaukee 3, Wis.
Poser, J. & Co., 251 W. 30th St., New York, N.Y.
Post Electric Co., Inc., P.O. Box 335, Andover, N.J.
Potdevin Machine Co., 294 North St., Teterboro, N.J.
Powers Plastics Co., Rowayton, Conn.
●Powers Regulator Co., The, 3400 Oakton St., Skokie, Ill.
●Powhatan Mining Co., 6721 Windsor Mill Rd., Baltimore 7, Md.
Pratt & Whitney Co., Inc., Charter Oak Ave., W. Hartford 1, Conn.
Preble, Harry Jr., Schoolhouse Rd., Cross River, N.Y.
Precise Instrument Parts Co., 4520 San Fernando Rd., Glendale 4, Calif.
Precision Coating Co., Inc., 37 Franklin St., Needham, Mass.
●Precision Extruders, Div. Lamex Chemical Co., 289 N. Main St., Leominster, Mass.
●Precision Mold & Polishing, P.O. Box 326, Roanoke, Va.
Precision Molded Plastics Inc., 2014 W. 53rd St., Cleveland 2, Ohio
Precision Plastic Products, Inc., 225 N. Racine, Chicago 7, Ill.
Precision Products Co., Inc., P.O. Box 71, E. Paterson, N.J.
Precision Specialties, Incorporated, 212 North Western Ave., Los Angeles 4, Calif.
Preis, H. P. Engraving Machine Co., 651 U.S. Highway 22, Hillside 5, N.J.
Premier Plastic Mfg. Co., 220 N. Fifth St., Minneapolis 3, Minn.
Premier Plastic Products, Inc., 3982 Broadway, Gary, Ind.
Premier Plastics Co., 204 W. Washington, Milwaukee 4, Wis.
Premier Thermo-Plastics Co., Middletown Rd., Jeffersontown, Ky.
Premier Vacuum Process Corporation, 58-87-55th St., Maspeth 78, L.I., N.Y.
Presco Plastics, 121 North Broadway, Milwaukee 1, Wis.
Preservation Packaging, Inc., 1407 Chestnut Ave., Hillside, N.J.
●Presque Isle Plastics, Inc., 2730 W. 12th St., Erie, Pa.
Pressure Sensitives, Inc., 7600 S. Greenwood Ave., Chicago 19, Ill.
Presto Plastic Products Co., Inc., 11 E. 26th St., New York, N.Y.
Pribble Plastics Products, Inc., 554 Eben St., New Haven, Ind.
Price Driscoll Corp., 520 Fifth Ave., New York 36, N.Y.
Primas Moldmakers, Inc., 240 Sheridan Ave,. Buffalo 11, N.Y.
Printing Industries Equipment Inc., 135 W. 20th St., New York, N.Y.
Printloid Plastics, Inc., 93 Mercer St., New York 12, N.Y.
Printon Corp., 304 E. 23rd St., New York 10, N.Y.
Prisonia Process, Inc., 9 E. 19th St., New York, N.Y.
Process Development Co., Inc., P.O. Box 19., Station A, Toledo 5, Ohio
Process Equipment Co., 6050 N. Whipple St., Chicago, Ill.
●Process Gear Co., 4616 Fullerton Ave., Chicago 39, Ill.
Process Mold Co., 19665 Schoenherr Ave., Detroit 5, Mich.
Proctor & Schwartz, Inc., 7th St. & Tabor Rd., Phila. 20, Pa.
Procunier Safety Chuck Co., 18 S. Clinton, Chicago 6, Ill.
●Prodex Corp., Fords, N. J.
Product Engineering & Development Co., 9 North Tyler Ave., Hopkins, Minn.
Production Aid, Inc., Middletown, Ky.
●Production Metal Prod. Co., 421 N. Sangamon St., Chicago 22, Ill.
Progressive Electronics Co., Inc., 120 Home Pl., Lodi, N.J.
●Progressive Machine Co., Inc., 198 E. 25th St., Paterson 4, N.J.
Progressive Molded Products Corp., 1100 S. Morgan St., Bluffton, Ind.
Progressive Plastics Mfg., Co., 175 E. 153 St., New York 51, N.Y.
Prolon Plastics Div., Pro-phy-lac-tic Brush Co. Florence, Mass.
Prostel, Albert & Sons, 1776 N. Commerce St., Milwaukee, Wis.
Protective Lining Corp., 22 Woodhull St., B'klyn 31, N.Y.
Protective Treatments, Inc., 420 Dellrose Ave., Dayton 3, Ohio
Prufcoat Laboratories, Inc., 63 Main St., Cambridge 42, Mass.
Puerto Rico Industrial Development, 579 5th Ave., New York 17, N.Y.
Pulva Corp., 550 High St., Perth Amboy, N.J.
●Pulverizing Machinery Div., Metals Disintegrating Co., Inc., 30 Chatham Rd., Summit, N.J.
Puritan Mfg. Co., The, 100 Watertown Ave., Waterbury 20, Conn.
Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.
Pyramid Chemical Co., 1345 Arch St., Phila. 7, Pa.
Pyramid Industrial Finishing Co., 431-3 Southern Blvd., New York 55, N.Y.
Pyramid Plastics, Inc., 554 W. Polk St., Chicago 7, Ill.
Pyramid Screen Corp., 181 Harvard St., Brookline 46, Mass.
●Pyro Plastics Corp., 690 Chestnut St., Union, N.J.
Pyrometer Instrument Co., Inc., 92 Portland Ave., Bergenfield, N.J.
Pyrotex Leather Co., 287 Whitney St., Leominster, Mass.
Pyroxylin Products, Inc., 4851 S. St. Louis Ave., Chicago 32, Ill.

Q

Quaker Oats Co., The, Merchandise Mart Plaza, Chicago 54, Ill.
Quality Tools Corp., P.O. Box 54, Merrick, L.I., N.Y.
Quarnstrom Tool Co., 6698 E. McNichols Rd., Detroit 12, Mich.
Quick Plastics, 1680 Cooper St., Jackson, Mich.
Quincy Compressor Co., 217 Maine St., Quincy, Ill.
●Quinn-Berry Corp., 2609 W. 12th St., Erie, Pa.

R

●R-B-H Dispersions, Div. of Interchemical Corp., 2 Hamilton St., Bound Brook, N.J.
R C A Industrial Equipment, Camden, N.J.
R. E. C. Mfg. Corp., 1250 Highland St., Holliston, Mass.
R & K Tool & Die Co., 3891 W. 150th St., Cleveland 11, Ohio
Radial Cutter Mfg. Corp., 831 Bond St., Elizabeth 4, N.J.
Radiant Heat Enterprises, Inc., 630 Morris & Essex Tpke., Short Hills, N.J.
Radiation Applications, Inc., 342 Madison Ave., New York 17, N.Y.
Radio Corp. of America, Industrial Products Section, Front & Cooper Sts., Camden 2, N.J.
●Radio Receptor Co., Inc., Thermatron Div., 251 W. 19th St., New York 11, N.Y.
Raffi & Swanson, Inc., 100 Eames St., Wilmington, Mass.
Rahn-Robbins Plastics & Rubber, Inc., 3383 E. Layton Ave., Cudahy, Wis.
Rainbow Plastic Products Co., 6012 Wayzata Blvd., Minneapolis 16, Minn.
Rainco Mfg., Inc., R.D. #2, Box 788, Franklin, Pa.
Rainville Co., Inc., The, 224 7th St., Garden City, N.Y.
Raleigh Enterprises, Inc., 900 Broadway, New York, N.Y.
Ralston, W. & Co., Inc., 60 Mt. Vernon Ave., Mt. Vernon, N.Y.
Ram Chemicals, 200 E. Olive, Gardena, Calif.
Rand Rubber Co., 397 Sumner Ave., B'klyn 16, N.Y.
Randazzo Plastic Co., 1536 W. Slauson Ave., Los Angeles 47, Calif.
Randolph Products Co., 12th St., Carlstadt, N.J.
Rank-Well Enterprises, Inc., P.O. Box 174, Tifton, Ga.
Rapids Machinery Co., Inc., 889-11th St., Marion, Iowa
●Raritan Industries, 2 E. 5th St., Paterson, N.J.
Ray Products Co., Inc., 703 S. Palm Ave., Alhambra, Calif.
Raybestos-Manhattan, Inc., 61 Willet St., Passaic, N. J.
Raybestos-Manhattan, Inc., Reinforced Plastics Dept., Manheim, Pa.
Rayette, Inc., 261 E. 5th St., St. Paul 1, Minn.
Raymond Laboratories, Inc., 261 E. 5th St., St. Paul 1, Minn.
●Rayon Processing Co., of R. I., Inc., 1 Moshassuck St., Pawtucket, R. I.
Rayonier Inc., 161 E. 42nd St., New York 17, N. Y.
Read Standard Div. Capitol Products Corp., York, Pa.
●Recto Molded Products, Inc., Appleton & B & O R. R., Cincinnati 9, Ohio
●Reed Plastics Corp., 116 Gold St., Worcester, Mass.
●Reed Prentice Corp., 677 Cambridge St., Worcester 4, Mass.
Reeve Electronics, Inc., 609 W. Lake St., Chicago 6, Ill.
Reeves Brothers, Inc., 54 Worth St., N. Y. 13, N. Y.
Reflin Co., 5730 Kearney Villa Rd., San Diego, Calif.
Regal Plastic Co., 2800 E. 14th St., Kansas City 27, Mo.
●Reichhold Chemicals, Inc., 525 North Broadway, White Plains, N. Y.

●Indicates Advertiser.

• Reifenhauser, A., Troisdorf Bez-Koln, Germany
Reinecke & Associates, 155 E. Ohio, Chicago 11, Ill.
Reinforced Plastic Tubing Co., The, 1526 W. 166th St., Gardena, Calif.
Reinforced Plastics Consultants, 1548 W. 135th St., Gardena, Calif.
Reinforced Plastics, Div. of Hays Mfg. Co., 12th & Liberty Sts., Erie 1, Pa.
Reinhardt, J. A. & Co., Mountain Home, Pa.
Reinhardt Plastics Co., 1611–15 Platte St., Denver 9, Colo.
Reinhold Engineering & Plastics Co., 12827 E. Imperial Highway, Norwalk, Calif.
Reinhold, F. E. Mfg., 7001 McKinley Ave., Los Angeles 1, Calif.
Reinhold-Geiger Plastics, Inc., 8763 Crocker St., Los Angeles 3, Calif.
Reiss Associates, Inc., Reiss Ave., Lowell, Mass.
• Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio
Reliance Plastic & Chemical Corp., 108–110 Kearney St., Paterson 2, N. J.
• Reliance Pattern Works, 4350–56 W. Chicago Ave., Chicago 51, Ill.
Ren Plastics, Inc., 5422 S. Cedar St., Lansing 17, Mich.
Republic Molding Corp., 6467 N. Avondale Ave., Chicago 31, Ill.
Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena 1, Calif.
Resin Industries, Inc., Sub. of The Borden Co., 315 Olive St., Santa Barbara, Calif.
Resin Research-Laboratories, Inc., 40 Adams St., Newark, N. J.
Resincraft Plastics, Inc., 42 W. Cermak Rd., Chicago 16, Ill.
Resinite Dept., The Borden Co., P.O. Box 1589, Santa Barbara, Calif.
• Resinoid Engineering Corp., 3445 Howard St., Skokie, Ill.
Resistoflex Corp., Woodland Rd., Roseland, N. J.
Reslac Chemicals, Inc., 3634 W. 38th St., Chicago, Ill.
Resolite Corp., Rt. 19, Box 336, Zelienople, Pa.
• Respro, Div., The General Tire & Rubber Co., 530 Wellington Ave., Cranston 10, R. I.
Revell, Industrial Div., 4223 Glencoe Ave., Venice, Calif.
Rex Corp., Hayward Rd., W. Acton, Mass.
Rex Plastics Co., Inc., 607 Seneca Creek Rd., Buffalo 24, N. Y.
Rexton Finishes, Inc., 62–70 Woolsey St., Irvington 11, N. J.
• Reynolds Chemical Products Co., 1200 N. Main St., Ann Arbor, Mich.
Reynolds Metals Co., 2500 S. 3rd St., Louisville, Ky.
Reynolds Metals Co., Plastic Div., Box 128, Grottoes, Va.
Reynolds Plastics, Inc., 3351 Oakley Park Rd., Walled Lake, Mich.
Rezolin, Inc., 1651–18th St., Santa Monica, Calif.
Rheem Mfg. Co., 4631 Firestone Blvd., South Gate, Calif.
Rhode Island Laboratories, Inc., 100 Pulaski St., W. Warwich, R. I.
Rhodes, Philip H. & Assoc., 4354 Hamilton Ave., Cincinnati 23, Ohio
Richard Alan Button Co., Factory Rd., Roosevelt, N. J.
Richards Chemical Works, Div. of Onyx Oil & Chemical Co., Warren & Morris Sts., Jersey City 2, N. J.
Richards, J. A. Co., 903 N. Pitcher St., Kalamazoo, Mich.
• Richardson Co., The, 2747 Lake St., Melrose Park, Ill.
Richter, Frederic A., 5520 S. Shore Dr., Chicago 37, Ill.
Rider Engineering & Plastic Co., 2175 2nd West, Salt Lake City, Utah
Ridge Printing Co., Inc., 535 Oritan Ave., Ridgefield, N. J.
Ridgefield Plastic Products Co., Route 7, Ridgefield, Conn.
• Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y.
Rilsan Corp., John Hancock Bldg., Boston, Mass.
• Ringler-Dorin, Inc., 315 Fifth Ave., New York
Ringler, F. A. Co., 418 W. 25th St., New York, N. Y.
Rippolite Plastic Products, Inc., 3910 Cohasset St., Burbank, Calif.
River Raisin Paper Co., 1109 E. Elm Ave., Monroe, Mich.
• Riverdale Color Co., 425 South St., Newark 5, N. J.
Riverdale Plastic & Chem. Corp., 8510 Warner Drive, Culver City, Calif.
Riverside Plastics Corp., Miller Rd., Hicksville, L. I., N. Y.
Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.
Robbins, Jim Co., 130 Stephenson Hwy. Royal Oak, Mich.
• Robbins Plastic Machinery Corp., 1430 Mishawaka St., Elkhart, Ind.
Robertshaw-Fulton Controls Co., Long Beach 5, Calif.
Robertson, H. H. Co., 2400 Farmers Bank Bldg., Pittsburgh 22, Pa.
Robinson Industries, Inc., Franklin Plastics Div., 315 Grant St., Franklin, Pa.
Robinson Moulded Products, Ltd., 183 George St., Toronto, Ontario, Canada
Robinson Plastics Corp., 132 Lafayette St., New York 13, N. Y.
Rochelle Plastic Mold Co., Inc., 35 Sebago St., Clifton, N. J.
Rock Island Millwork Co., 2525 4th Ave., Rock Island, Ill.
Rockford Moulded Products, Inc., 2230 Kishwaukee St., Rockford, Ill.
Rockwell, W. S. Co., 2706 Elliot St., Fairfield, Conn.
• Roehlen Engraving Works, Inc., 324 St. Paul St., Rochester, N. Y.
• Rogan Bros., 8029 N. Monticello Ave., Skokie, Ill.
Roger Model Shop, 244 Central St., Leominster, Mass.
• Rogers Corp., Rogers, Conn.
Rogers Plastic Corp., West Warren, Mass.
Roger's Product Design, 244 Central St., Leominster, Mich.
Rogers, V. F., 4320 Fox St., Denver, Colo.
Rohden Mfg. Co., 4739 W. Montrose Ave., Chicago 41, Ill.
• Rohm & Haas Co., Washington Sq., Phila. 5, Pa.
• Rohm & Haas Co., Resinous Products Div., Washington Sq., Phila., Pa.
Rolls, Inc., 1240 E. 14th St., Brooklyn, N. Y.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse, N. Y.
Romar Plastics, Inc., 1311 E. Main St., St. Charles, Ill.
Rome Plastic Specialties, Inc., 11 Harrison St., Worcester, Mass.
• Rona Laboratories, Inc., 352 Doremus Ave., Newark, N. J.
Rondale Co., Inc., The, 161 E. 11th Ave., Roselle, N. J.
Rosbro Plastics Corp., 34 Ormsbee Ave., Providence 1, R. I.
Rosenberg Bros. & Co., Smithtown, N. Y.
Rosenthal, Alfred A., 3 Park Row, New York 38, N. Y.
Ross & Roberts Co., 1299 W. Broad St., Stratford, Conn.
Ross & Roberts Sales Co., Inc., 350–5th Ave., New York 1, N. Y.
• Ross, Charles & Son Co., 148–156 Classon Ave., B'klyn 5, N. Y.
Ross, Gene, 35 Madison Ave., N. Y., N. Y.
Rostone Corp., 135 Earl Ave., Lafayette, Ind.
Rothenstein, Guy G., 99–05–63rd Dr., Forest Hills, 74, N. Y.
Rotherm Engineering Co., Inc., 7280 W. Devon Ave., Chicago 31, Ill.
• Rotuba Extruders, Inc., 437–88th St., B'klyn 9, N. Y.
Rowland Products, Inc., 220 Fairview Lane, Kensington, Conn.
Royal Mfg. Co., Inc., 200 N. Granite St., Prescott, Ariz.
Royal Master, Inc., State Hwy. 23, Riverdale, N. J.
Royal Plastics Co., Prescott, Ariz.
• Royalite Plastics Products, United States Rubber Co., 2638 N. Pulaski Rd., Chicago 39, Ill.
• Royle, John & Sons, 10 Essex St., Paterson 39, N. J.
Rubatex Div., Great American Industries, Inc., Bedford, Va.
Rubba, Inc., 1015 E. 173rd St., New York 60, N. Y.
• Rubber & Asbestos Corp., 243 Belleville Ave., Bloomfield, N. J.
• Rubber Corp. of America, 225 Broadway, New York, N. Y.
Rucker Co., The, 4228 Hollis St., Oakland 8, Calif.
Rudd Plastic Fabrics Corp., 620 62nd St., Brooklyn 20, N. Y.
Ruf Machine Co., Inc., 416 E. 93rd St., New York 28, N. Y.
Ruhrstahl Aktiengesellschaft Heinrichshutte, Hattingenruhr, W. Germ.
Russell, James, Engineering Works, 9 Dewar St., Boston 25, Mass.
Russell Reinforced Plastics Corp., 521 Hoffman Ave., Lindenhurst, N. Y.
Rutherford Machinery Corp., Div. Sun Chemical Corp., 10th St. & 44th Ave., Long Island City 1, N. Y.
Ruthman Machinery Co., The, 1809 Reading Rd., Cincinnati 2, Ohio
Ryerson, Joseph T. & Son, Inc., 16th & Rockwell Sts., Chicago, Ill.

S

S K W Mfg. Co., 4632 N. Lamon Ave., Chicago 30, Ill.
Sadtler, Samuel P. & Son, Inc., 1517 Vine St., Phila. 2, Pa.
• Safety Industries, Inc., Entoleter Div., 1187 Dixwell Ave., Hamden 16, Connecticut
St. Clair Plastics Corp., 1295 S. Parker St., Marine City, Mich.
St. Clair Rubber Co., 440 E. Jefferson Ave., Detroit 26, Mich.

• Indicates Advertiser.

St. Regis Paper Co., Panelyte Div., 150 E. RWnd St., New York, N. Y.
Sakier, George, 340 E. 71st St., New York 22, N. Y.
Saman Plastics Corp., 97 Classon Ave., B'klyn 5, N. Y.
● Sandee Mfg. Co., 5050 W. Foster Ave., Chicago 30, Ill.
● Sandman, Eli Co., 30 Wyman St., Worcester 10, Mass.
Sandstrom, J. G., Grinding Wheel Co., 922 St. James Ave., Springfield 4, Mass.
Sanitized Sales Co. of America, The, 181 Madison Ave., New York 16, New York
Santa Barbara Plastics Corp., Santa Barbara Airport, Goleta, Calif.
● Santay Corp., 351 N. Crawford, Chicago, 24, Ill.
Saphier, Michael Associates, Inc., 350 Madison Ave., New York 10, N.Y.
Saratoga Plastics Inc., North Walpole, N.H.
● Sarco Co., Inc., 350 Fifth Ave., New York 1, N.Y.
Sarcol Foundry & Pattern Corp., 3050 W. Taylor St., Chicago 12, Ill.
Scamar Mfg. Co., 102–106 Straight St., Paterson, N.J.
Schaake, A. J. Co., 486 Selby Ave., St. Paul 2, Minn.
Schauer Mfg. Corp., 4500 Alpine Ave., Cincinnati 36, Ohio
Schick Mfg. Co., 9–20 38th Ave., L.I.C., N.Y.
Schlesinger, J. George, 550 5th Ave., New York, N.Y.
Schnur-Appel Design Consultants, 2165 Morris Ave., Union, N.J.
Schori Process Div., Ferro-co Corp., 8–11 43rd Rd., Long Island City 1, N.Y.
Schreiter, F. R., Inc., 179 Brook St., Clinton, Mass.
● Schulman, A. Inc., 790 E. Tallmadge Ave., Akron 9, Ohio
Schulz, Richard O. Co., 2425 N. 75th Ave., Elmwood Park 35, Ill.
Schutz-O'Neill Co., 307 Portland Ave., Minneapolis 15, Minn.
● Schwab Plastics Corp., 730 S. Dix, Detroit 17, Mich.
● Schwartz Chemical Co., Inc., 326 W. 70th St., New York 23, N.Y.
Schwarzfaerber & Co., G.m.b.H., 42 Geisseestrasse, Nurnberg, Germany
Schwebel, J. P. & Co., Inc., 424 Madison Ave., New York 17, N.Y.
Scientific Abrasives, 5100 N. Canfield Rd., Chicago 31, Ill.
● Scott Testers, Inc., 96 Blackstone, Providence 1, R.I.
● Scranton Plastic Laminating Corp., 3218 Pittston Ave., Scranton 6, Pa.
Screen-O-Printer Mfg. Co., 247 Columbia, Adams, Mass.
Seal Cast Co., Inc., 2635 E. Hagert St., Philadelphia 33, Pa.
Seal Peel, Inc., 775 Stephen Hwy., Royal Oak 3, Mich.
Sealview Plastics, Inc., 232 Conestoga Rd., Wayne, Pa.
Sealine Mfg. Co., 4716 W. Lake St., Chicago 44, Ill.
● Sealomatic Electronics Corp., Dept. P., 429 Kent Ave., B'klyn, N.Y.
Sealy Plastics Corp., 98 E. Main St., Box 489, Rockville, Conn.
Seamlex Co., Inc., 4123 24th St., Long Island City, N.Y.
● Seiberling Rubber Co., Plastics Div., Newcomerstown, Ohio
Sepanski & Associates, 900 Clancy NE, Grand Rapids 5, Mich.
● Service Plastics Inc., 1118 W. Jackson Blvd., Chicago 7, Ill.
● Servospeed, Inc., 4–6 Godwin Ave., Paterson 1, N.J.
Servwell Products Co., The, 6541 Euclid Ave., Cleveland 3, Ohio
Set Screw & Mfg. Co., Bartlett, Ill.
Seward Industries, Inc., 111 Hudson St., New York 13, N.Y.
Shakeproof Div. of Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.
Shamban, W. S. & Co., 11617 W. Jefferson Blvd., Culver City, Calif.
Sharpe Plastics, Inc., P. O. Box 247, Sudbury, Mass.
Sharples Chemicals, Div., Pennsylvania Salt Mfg. Co., Three Penn Center Plaza, Phila. 2, Pa.
Shasta Mfg. Co., 276 Snyder Ave., Berkeley Hts., N.J.
Shasta Mfg., Inc., 422–424 Broadway, Akron 8, Ohio
● Shaw, Francis & Co., Ltd., Corbett St., Manchester 11, England
Shaw Industries, Inc., Box 591, Franklin, Pa.
● Shaw Insulator Co., 160 Coit St., Irvington 11, N.J.
Shaw-Randall Co., Inc., 39 Sabin St., Pawtucket, R.I.
Shawinigan Products Corp., 350 Fifth Ave., New York 1, N.Y.
Shawinigan Resins Corp., 644 Monsanto Ave., Springfield 1, Mass.
● Sheffield Plastics, Inc., Salisbury Rd., Sheffield, Mass.
● Shell Chemical Corp., 380 Madison Ave., New York 17, N.Y.
Shell Oil Co., 50 W. 50th St., New York 20, N.Y.
Shellmar-Betner Div., Continental Can Co., 100 E. 42nd St., New York 17, N.Y.
Shepherd, J. H. Son & Co., 1820 East Ave., Elyria, Ohio
Sheridan-Gray, Inc., 24701 Crenshaw Blvd., Torrance, Calif.
Sherman Industrial Electronics Co., 505 Washington Ave., Belleville, N.J.
Sherman Rubber Machinery Co., 2 Sherman St., Worcester 1, Mass.
Sherwin-Williams Co., The, Pigment, Color & Chemical Div., 260 Madison Ave., New York 16, N.Y.
Shoe Form Co., Inc., 26 Aurelius Ave., Auburn, N.Y.
Shore Line Industries, Inc., Railroad Ave., Clinton, Conn.
Shriver, T. & Co., Inc., 882 Hamilton St., Harrison, N.J.
Shuman, Philip & Sons, 15–33 Goethe St., Buffalo 6, N.Y.
Si Lite, Inc., 2511–31 W. 18th St., Chicago 8, Ill.
Seibert, Rudolph R. Co., 183 St. Paul St., Rochester 4, N.Y.
Siempelkamp, G. & Co., Ritterstr. 213, Krefield, Germany
● Sierra Electric Corp., 15100 S. Figueroa, Gardena, Calif.
Sierra Products Co., 1632 E. Compton Blvd., Compton, Calif.
Sierracin Corp., The, 1121 Isabel St., Burbank, Calif.
Sigma Specialty Chemicals, 865 S. 10th St., Richmond, Calif.
Silicone Insulation, Inc., Seabury Ave. & Butler Pl., Bx. 61, N.Y.
Silin Research Associates, 9390 Lem Turner Rd., Jacksonville, Fla.
Sill Industries, 187 Maplewood Ave., Maplewood, N.J.
● Silicocks-Miller Co., The, 10 W. Parker Ave., Maplewood, N.J.
● Simplomatic Mfg. Co., 4416 W. Chicago Ave., Chicago 51, Ill.
Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.
● Sinclair-Collins Valve Co., 454 Margar Ave., Akron 11, Ohio
Sindar Corp., 330 W. 42nd St., New York 36, N.Y.
Singer, Lawrence H., 16 W. 46th St., New York 36, N.Y.
Singer, Lawrence H., Industrial Design, 66 Briar Lane, Jericho, N.Y.
Singer Mfg. Co., Diehl Mfg. Co., Electrical Div., 1178 Finderne Ave., Somerville, N.J.
Singleton & Mack, Inc., 1st Natl. Bank Bldg., Marietta, Ohio
● Sinko Mfg. & Tool Co., 3135 W. Grand Ave., Chicago 22, Ill.
Sirotta, Bernard Co., 610 Smith St., B'klyn 31, N.Y.
Size Control Co., Div. of American Gage & Machine Co., 2500 W. Washington Blvd., Chicago 12, Ill.
Skeist Labs., 89 Lincoln Park, Newark 2, N.J.
Skinner Engine Co., Erie, Pa.
Skyline Industries–Skyline Plastic Pipe, Inc.,–Skyline Plastic Molding, Inc., Titsuville, Pa.
Slomons Labs., Inc., 31-27 Thomson Ave., Long Island City 1, N.Y.
Smith Chemical & Color Co., Inc., 55 John St., B'klyn 1, N.Y.
Smith, H. P. Paper Co., 5001 W. 66th St., Chicago 38, Ill.
Snyder Chemical Corp., Henry St., Bethel, Conn.
So-Lo Works, Inc., Loveland, Ohio
● Sobenite, Inc., 1026 W. King St., S. Bend 16, Ind.
Societe de L'Electronique Francaise, Boulevard Voltaire 68, Asnieres (Seine), France
Societa Italiana Della Celluloide, Castiglione Olona, Verese, Italy
Society of Plastics Engineers, Inc., 34 E. Putnam Ave., Greenwich, Conn.
Society of the Plastics Industry, Inc., 250 Park Ave., New York, N.Y.
Socony Mobil Oil Co., Inc., 26 Broadway, New York 4, N.Y.
Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
Solar Plastic Products Co., 1635 E. 16th St., Brooklyn 29, N.Y.
Solem Machine Co., Merritt-Solem Div., 120 S. Niagara St., Lockport, N.Y.
Solid-Art Co., 5910 Yorkwood Rd., Baltimore 12, Md.
● Solvay Sales Div., Allied Chem. & Dye Corp., 61 Broadway, New York 6, N.Y.
Solvic Society Anonyme, 244, rue de la Loi, Brussels, Belgium
Somerset Industrial Designs, Inc., Vanderveer Parkway, Somerville, N.J.
Sommer & Maca Glass Mach. Co., 3600 S. Oakley Ave., Chicago, Ill.
Sommers Plastics Products Co., 7-9 W. 18th St., New York, N.Y.
Sonoco Products Co., Hartsville, S.C.
Sorg Paper Co., The, 901 Manchester Ave., Middletown, Ohio
South California Plastic Co., 1805 Flower St., Glendale 1, Calif.
● South Florida Test Service, 4201 N.W. 7th St., Miami 34, Fla.

● Indicates Advertiser.

South Gate Tool & Eng. Co., South Gate, Calif.
South Salem Studios, Old Ridgefield Rd., S. Salem, N.Y.
•Southern Plastics Co., 408 Pendleton St., Columbia 1, S.C.
Southern Plastics Eng. Corp., U.S. Rt. 29, N., Greensboro, N.C.
Southern Plastic Products Co., 948-950 Ave. E, Riviera Beach, Fla.
Southern Screw Co., P.O. Box 1360, Statesville, N.C.
Southern Tool Mfg. Co., 649 Waughton St., Winston-Salem, N.C.
Southwestern Plastic Pipe Co., Div., Texas Vitrifield Pipe Co., Mineral Wells, Texas
Spadone Machine Co., Inc., Connecticut Ave., South Norwalk, Conn.
Spartan Industrial Corp., 51 Chambers St., New York 7, N.Y.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N.Y.
Special Products Div., Weyerhaeuser Timber Co., P.O. Box 1645, Tacoma 1, Wash.
Specialized Plating Co., 2238 Purdue Ave., W. Los Angeles 64, Calif.
Specialties Imprinting Co., 113 St. Clair Ave. N.E., Cleveland 14, Ohio
•Specialty Chemicals Inc., McNeil Rd., Rt. 4, Box 156, Austin, Texas
Specialty Insulation Mfg. Co., Inc., Center St., Hoosick Falls, N.Y.
Specialty Products Co., 190 Warren St., Jersey City, N.J.
Specialty Resins, Inc., 842 N. Wells St., Chicago 10, Ill. & 32rd & Spring Garden Sq., Phila 4, Pa.
•Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.
Spencer Turbine Co., The, 486 New Park Ave.. Harfordt 6, Conn.
Sperzel Co., 2845 Harriet Ave., S., Minneapolis 8, Minn.
Spier, Franklin Inc., 232 Madison Ave., New York 16, N.Y.
Sprayiat Corp., 1 Park Ave., New York 16, N.Y.
Springfield Cast Products, Inc., 124 Switzer Ave., Springfield 9, Mass.
Springfield Fabricators, Inc., 697 Morris Tpke., Springfield, N.J.
Springfield Moulders, Inc., 30 Cushman St., Monson, Mass.
Springfield Pattern Works, Inc., 124 Switzer Ave., Springfield 9, Mass.
Springfield Tool & Die Co., Inc., 109 Springfield Ave., Springfield, N.J.
Sprout, Waldron & Co., Inc., Sherman St., Muncy, Pa.
Square D Co., Molded Insulation Div. N. Tippecanoe St., Peru, Ind.
Staff Die Cutting Co., 40 W. 22nd St., New York 10, N.Y.
Stagg, W. Howard, 2113 E. Sargent St., Philadelphia 25, Pa.
Stahl, Gerald, 12 E. 46th St., New York 17, N.Y.
Standard Cap & Molding Co., Inc., 307 S. Eaton St., Baltimore, Md.
Standard Coated Products, Inc., Buchanan, N.Y.
Standard Conveyor Co., 319 N. W. 2nd St., N. St. Paul 9, Minn.
Standard Electric Mfg. Co., Inc., Haddon Ave., W. Berlin, N.J.
•Standard Insulation Co., 74 Paterson Ave., E. Rutherford, N.J.
Standard-Knapp, Div., Emhart Mfg. Co., Portland, Conn.
Standard Machinery Co., 12 Water, Mystic, Conn.
•Standard Molding Corp., 1517 E. Third St., Dayton 3, Ohio
Standard Oil Co., 3083 Broadway, Cleveland, Ohio
Standard Oil Co. of Calif., Product Acceptance Dept., Standard Oil Bldg., San Francisco, Calif.
Standard Plastics Co., Inc., 62 Water St., Attleboro, Mass.
Standard Plastics, Inc., R.D.#1, Breiningsville
Standard Pyroxoloid Corp., 85 Pleasant St., Leominster, Mass.
•Standard Tool Co., 47 Hamilton St., Leominster, Mass.
Standard Ultramarine & Color Co., 24th St. & 5th Ave., Huntington, W. Va.
Standard-Union Fibre Co., P.O. Box 4755, 2950 E. Tioga St., Phil. 34, Pa.
•Stanley Chemical Co., The, E. Berlin, Conn.
Star Chem. Co., 9830 Derby Lane, Westchester, Ill.
Star Die & Supply Co., 19 Stewart St., Lynn, Mass.
Star Mfg., Inc., 105 Industrial Ave., Little Ferry, N.J.
Staub, David E., 111 Quimby, Westfield, N.J.
Steckler, R. Laboratories, 8200 Harvard Ave., Cleveland 5, Ohio
Steere Enterprises, Inc., 422 S. Broadway, Akron 8, Ohio
Stein Equipment Co., 107 8th St., Brooklyn 15, N.Y.
Stein, Hall & Co., Inc., 285 Madison Ave., New York 17, N.Y.
Steiner Plastic Mfg. Co., Inc., Pratt Oval, Glen Cove, N.Y.
Stellaron Corp., 185 Madison Ave., New York, N.Y.
Stelray Products, Inc. Suby. Derby-Shelton Silver Co., 65 Shelton Ave., Shelton, Conn.
Stensgaard, W. L. & Assoc., Inc., 346 N. Justine St., Chicago 7, Ill.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
•Sterling, Inc., 3738 N. Holton St., Milwaukee 12, Wis.
Sterling Molders, Inc., 277 Military Rd., Buffalo 7, N.Y.
Sterling Plastics Co., 1140 Commerce Ave., Union, N.J.
Stevens, Howard, Associates, Edgartown, Mass.
Stewart, F. S. Associates, 10819 Venice Blvd., Los Angeles 34, Calif.
Stimsonite Div., Elastic Stop Nut Corp. of America, 3445 N. Kimball Ave., Chicago 18, Ill.
•Stokes, F. J. Machine Co., 5500 Tabor Rd., Philadelphia 20, Pa.
Stokes Molded Products, Inc., 110 Taylor St., Trenton 4, N.J.
Stokes-Trenton, Inc., 150 Enterprise Ave., Trenton 9, N.J.
Stone, S. G. Tube Machine Corp., 1770 W. Berteau Ave., Chicago 13, Ill.
Stoner-Mudge, Inc., 2000 Westhall St., Pittsburgh 33, Pa.
Stow Mfg. Co., 443 State St., Binghamton, N.Y.
Stowe-Woodward, Inc., 181 Oak St., Newton Upper Falls 64, Mass.
Strabeg Machine Co., 828-830 Home St., Bronx 59, N.Y.
Streamline Plastics Co., 175 Prince St., New York 12, N.Y.
Stressen-Reuter, Inc., 2113 Medill Ave., Chicago 47, Ill.
Strick Co., Whitaker & Godfrey Ave., Philadelphia 24, Pa.
Strick Plastics, Spruce & North Sts., Perkasie, Pa.
Strick Trailers, Div. of Fruehauf Trailer Co., Spruce St., Perkasie, Pa.
Stricker, Carl, 35 Leo Terrace, Bloomfield, N.J.
•Stricker-Brunhuber Corp., 19 W. 24th St., New York 10, N.Y.
Stringfield, Raymond B., 229 S. Normandie Ave., Los Angeles 4, Calif.
Stritch, F. W. Co., P.O. Box 274, Passaic, N.J.
•Stromes Systems, Inc., 411 E. 108th St., New York, N.Y.
•Structurlite Plastics Corp., 85 High St., Hebron, Ohio
Strux Corp., 14 South 13th St., Lindenhurst, N.Y.
Studebaker Hydraulic Products Co., 1733 N. 33rd Ave., Melrose Pk., Ill.
Studebaker Machine Co., 1221 S. Ninth, Maywood, Ill.
Sturtevant Mill Co., 110 Clayton St., Boston 22, Mass.
Styrene Products Ltd., 96 Piccadilly, London, W. I., England
Success Plastics Recovery Works, P.O. Box 506, Indianapolis 6, Ind.
•Sullivan Chemicals Div., 420 Hart St., Chicago 22, Ill.
•Sullivan Varnish Co., 420 N. Hart St., Chicago, Ill.
•Sun Chemical Corp., Electro-Technical Products Div., 113 E. Centre St., Nutley 10, N.J.
•Sun Chemical Corp., Warwick Chemical Co., Div., 10-10 44th Ave., L. I. C. 1, N.Y.
Sun Plastic, Inc., 2834 Vincent St., Cuyahoga Falls, Ohio
•Sunlite Plastics, Inc., 1506 W. Pierce, Milwaukee 46, Wis.
Super Tool Co., 21650 Hoover Rd., Detroit 13, Mich.
Superior Laminating Co., 89 Ridge St., New York 2, N.Y.
Superior Materials, Inc., 120 Liberty St., New York 6, N.Y.
•Superior Plastics, Inc., 410-430 N. Oakley Blvd., Chicago 12, Ill.
Supplex Co., 225 North Ave., Garwood, N.J.
Surprenant Mfg. Co., 172 Sterling St., Clinton, Mass.
Swan-Finch Oil Corp., 338 Hudson St., Hackensack, N.J.
•Swedlow Plastics Co., 6986 Bandini Blvd., Los Angeles 22, Calif.
•Swedlow Plastics Co., Youngstown, Ohio
Swenson, V. H. Co., Inc., 550 Elm St., Arlington, N.J.
Swift & Co., Union Stock Yards, Chicago 9, Ill.
Swift, M. & Sons, Inc., 10 Love Lane, Hartford 1, Conn.
Sylvan Plastics, Inc., 350 Fifth Ave., New York 1, N.Y.
Sylvania Div., American Viscose Corp., 1617 Pennsylvania Blvd., Philadelphia 3, Pa.
•Sylvania Electric Products Inc., 12 Second Ave., Warren, Pa.
•Sylvania Electric Products, Inc., Tungsten Div., Towanda, Pa.
Symons, Ralph B. Assoc., 3571 Main Rd., Tiverton, R.I.
Synco Resins, Inc., Henry St., Bethel, Conn.
Synthane Corp., Montgomery Ave., Oaks, Pa.
Synthetic Chemicals, Inc., 335 McLean Blvd., Paterson 4, N.J.

• Indicates Advertiser.

Synthetic Mica Corp., Passaic Ave., Caldwell Twp., N.J.
Synthetic Plastics Co., 88 St. Francis St., Newark, N.J.
•Synthetic Products Co., 1636 Wayside Rd., Cleveland 12, Ohio
Synvar Corp., 726 King St., Wilmington, Del.
Syracuse Plastics Molders, 106 Mechanic St., Syracuse 1, N.Y.

T

T. C. Wheaton Co., Mays Landing, N.J.
T & M Machine & Tool Co., 15–17 Greenpoint Ave., Brooklyn 22, N.Y.
TMC Industrial Corp., 135 Hoyt Ave., Mamaroneck, N.Y.
T. O. Plastics, 2901 E. 78th St., Minneapolis 23, Minn.
Taber Instrument Corp., 111 Goundry St., N. Tonawanda, N.Y.
Tapper Plastics Machinery, 30. S. Broadway, Yonkers, N.Y.
Taussig, F. H., 175 W. 76th St., New York 23, N.Y.
Taylor & Greenbough Co., 20–30 Beaver Rd., Wethersfield 9, Conn.
Taylor Fibre Co., Norristown, Pa.
•Taylor Instrument Companies, 95 Ames St., Rochester 1, N.Y.
•Taylor, Stiles & Co., Riegelsville, N.J.
Teal Co., 69 Wheeler St., New Haven 11, Conn.
Tech-Art Plastics Co., Ridgedale Ave., Morristown, N.J.
Technical Ply-Woods, 228 N. La Salle St., Chicago 1, Ill.
Technical Processes Div., Colonial Alloys Co., Ridge & W. Crawford St., Philadelphia 29, Pa.
Technical Tape Corp., 177th St., & Harlem River, New York, N.Y.
Technicraft Co., 1156 Commonwealth Ave., Boston 34, Mass.
Tell, Jay W., 750 Fairfield Ave., Kenilworth, N.J.
Temco Winders, Inc., 134 Thurbers Ave., Providence 5, R.I.
Tempil Corp., 132 W. 22nd St., New York 11, N.Y.
Tench, Marvin E. Co., 5252 W. Kinzie, Chicago, Ill.
•Tennessee Eastman Co., Div. Eastman Kodak Co., Kingsport, Tenn.
Tennessee Products & Chemical Corp., Nashville 3, Tenn.
Tenney Engineering Inc., 1090 Springfield Rd., Union, N.J.
Tensikut Div., Seiburg Industries, Inc., Horse Plain Rd., New Britain, Conn.
Terkelsen Machine Co., 326 A St., Boston 10, Mass.
Terox Mfg. Corp., 3550 N. Lombard Ave., Franklin Park, Ill.
Testing Machines Inc., 123 W. 64th St., New York 23, N.Y.
Texas Glass Fiber Corp., P.O. Box 478, Grandview, Texas
Texas Plastic Products Co., 1501 Gazin St., Houston 20, Texas
Texas Vitrified Pipe Co., Southwestern Plastic Pipe Co., Div., Mineral Wells, Texas
•Textileather Corp., Div., General Tire & Rubber Co., 607 Madison Ave., Toledo 3, Ohio
Thal, Bernard, 791 Tremont St., Boston 18, Mass.
Thalco, 765 S. Harvard Blvd., Los Angeles 5, Calif.

•Indicates Advertiser.

Therm-O-Form Plastics Co., 17641 Ashland Ave., Homewood, Ill.
Therm-O-Plastic Prods., Airport St., Urbana, Ohio
Thermaflow Chemical Corp., P.O. Box 155 Tunkhannock, Pa.
Thermafoam Corp., Metuchen, N.J.
•Thermatron Div., Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N.Y.
•Thermel, Inc., 9400 Robinson Rd., Franklin Park, Ill.
Thermex Div., Girdler Co., The, Div., National Cylinder Gas Co., 224 E. Broadway, Louisville, Ky.
•Thermo Electric Co., Inc., Rochelle Park Post Office, Saddle Brook, N.J.
Thermoid Corp., Fairground Dr., Manlius, N.Y.
Thermold Corp., Fairground Dr., Manlius, N.Y.
Thermomat Co., Inc., 300 Maple Ave., Trenton 8, N.J.
Thermoplastic Processes, Inc., Valley Rd., Stirling, N.J.
•Thierica Studio, 900 Clancy Ave., NE, Grand Rapids 4, Mich.
Thiokol Chemical Corp., 780 N. Clinton, Trenton 7, N.J.
Thomas Mfg. Corp., 80 Clinton St., Newark 5, N.J.
Thomaston Mills, E. Main St., Thomaston, Ga.
Thombert, Inc., 316 E. 8th St., N., Newton, Iowa
Thompson & Co., 1085 Allegheny Ave., Oakmont, Pa.
Thompson, H. I. Fiber Glass Co., 1733 Cordova St., Los Angeles 7, Calif.
Thor Enterprises, Inc., Parker Rd., Long Valley, N.J.
•Thoreson-McCosh, Inc., 18208 W. McNichols Rd., Detroit 19, Mich.
•Thropp, Wm. R. & Sons Co., Div., J. M. Lehmann Co., Inc., 550 New York Ave., Lyndhurst, N.J.
Thwing-Albert Instrument Co., 5398 Pulaski Ave., Phila. 44, Pa.
Tico Plastics, Inc., 55 W. 13th St., New York 11, N.Y.
Tiger Plastics, 307 Richardson St., Brooklyn 22, N.Y.
•Tilp, J. G., Inc., Springfield & Milltown Rd., Union, N.J.
Time Saving Specialties, 2816 Dupont Ave. S., Minneapolis 8, Minn.
Timely Products Mfg. Co., 308 Rodgers Rd., Des Moines 15, Iowa
Timken Roller Bearing Co., The, 1835 Dueber Ave. S.W., Canton 6, Ohio
Tincher Products Co., 2023 S. 60th St., Milwaukee 14, Wis.
Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa.
Tinnerman Products, Inc., Dept. 16, P.O. Box 6688, Cleveland 1, Ohio
Titanium Pigment Corp., 111 Broadway, New York 6, N.Y.
Todaro, S., Co., 52 Trinity Pl., Buffalo 1, N.Y.
Toepfer, Alfred C. Inc., 1 Broadway, New York, N.Y.
Toledo Plastics Co., 397 Phillips Ave., Toledo 12, Ohio
Toledo Scale Co., Telegraph Rd., Toledo 1, Ohio
Topflight Corp., 160 E. 9th Ave., York, Pa.
Torsion Balance Co., The, 35 Monhegan St., Clifton, N.J.
Tote System, Inc., 700 South Seventh St., Beatric, Nebr.
Tracerlab, Inc., 130 High St., Waltham 54. Mass.

Trans-Matic Plastics Co., 5501 W. Montrose Ave., Chicago 41, Ill.
Transeal, Ltd., 100 Oak Tree Ave., S. Plainfield, N.J.
•Transilwrap Co., 2814 W. Fullerton Ave., Chicago 47, Ill.
•Transmatic Plastics Co., 5501 W. Montrose Ave., Chicago, Ill.
Transplastics Fabricating Co., 34 Cambria St., Boston 15, Mass.
Traver Corp., 358 W. Ontario St., Chicago 10, Ill.
Traver Investment Corp., 1092 Bluff Rd., Glencoe, Ill.
Tri-Angle Tool & Machine Works, 8623 Dice Rd., Los Nietos, Calif.
Tri-Point Plastics, Inc., 175–177 I. V. Willets Rd., Albertson L.I., N.Y.
Tri-State Die Casting, Henderson, Ky.
Tri-State Plastic Molding Co., Inc., 505 4th St., Henderson, Ky.
Triangle Development Co., 1711 W. 10th St., Brooklyn 23, N.Y.
Trim Molded Products Co., Inc., Route 5, Box 65A, Burlington, Wis.
Trimount Plastic Co., Inc., 71 Dudley St., Arlington, Mass.
Triploil Refining Co., 3134 California St., N.E., Minneapolis 13, Minn.
Trisonic Process Inc., 9 E. 19th St., New York 3, N.Y.
Trivac Co., Div. Specialized Plating Co., 2029 Granville Ave., Los Angeles 25, Calif.
Tronamatic Machine Mfg. Corp., 1881 Park Ave., New York 35 N.Y.
Trostel, Albert & Sons Co., 1776 N. Commerce Ave., Milwaukee 1, Wis.
•Troy Blanket Mills, 200 Madison Ave., New York, N.Y.
True Seal Div., Flick-Ready Corp., Melrose Park, Ill.
•Trulizi, Ambrogio, S.A.S., Via Giovanni da Piocida 8, Milan, Italy
Truscon Labs., Div. Devoe & Raynolds, 1700 Caniff St., Detroit 11, Mich.
Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.
Tulsa Plastics, 2253–55 E. 11th St., Tulsa, Okla.
•Tumb-L-Matic, Inc., St. Marys St., Stamford, Conn.
Tumble-Buff Labs, Inc., 95–10 Tuckerton St., Jamaica 33, N.Y.
•Tupper Corp., Great Road, Woonsocket, R.I.
Turbine Equipment Corp., Hynes Electric Div., 63 Vesey St., New York, N.Y.
Turchan Follower Machine Co., P.O. Box 6055, Dearborn 9, Mich.
Turner Devices, Inc., 2500 Baldwin St., St. Louis 6, Mo.
Turner Halsey Co., 40 Worth St., New York 13, N.Y.
Turner Tanning Machine Co., 65 Walnut St., Peabody, Mass.
•Twentieth Century Plastics Co., 4210 N. Sayre Ave., Chicago 18, Ill.
Twiss, House of J. Hayden, 500 5th Ave., New York, N.Y.
Tybond Products Co., 2453 N. Western Ave., Chicago 47, Ill.
Tylene Plastics, Inc., Freyer Rd., Michigan City, Ind.

U

U.B.S. Chemical Corp., 491 Main St., Cambridge 42, Mass.
Uhlich, Paul & Co., Inc., 90 West St., New York 6, N.Y.
Ulano Products Co., 610 Dean St., Brooklyn 38, N.Y.

Ultra Electroforming & Mfg. Co., 110 Cedar Ave., Pitman 7, N.J.
Una-Craft Engineering Co., Inc., 2209 E. 8 Mile Rd., Hazel Park, Mich.
Union Bay State Chemical Co., Inc., 491 Main St., Cambridge 42, Mass.
•Union Carbide & Carbon Corp., Bakelite Co., Div., 30 E. 42nd St., New York 17, N.Y.
•Union Carbide & Carbon Corp., Carbide & Carbon Chemicals Div., 30 E. 42nd St., New York 17, N.Y.
•Union Carbide International, 295 Madi- Ave., New York, N.Y.
Union City Filament Corp., 540-39th St., Union City, N.J.
Union Oil Co. of Calif., 617 W. 7th St., Los Angeles 17, Calif.
Union Paste Co., 1605 Hyde Park Ave., Hyde Park 36, Mass.
Union Products, Inc., 511 Lancaster St., Leominster, Mass.
Union Twist Drill Co., Monroe St., Athol, Mass.
Unipart, Inc., 501 Webster St., Palo Alto, Calif.
United Chromium, Inc., 100 E. 42nd St., New York 17, N.Y.
United Die Models, Inc., 4045 S. Kedzie Ave., Chicago 32, Ill.
United Laboratories Co., Inc., 801 E. Linden Ave., Linden, N.J.
•United Laminations, Inc., 1311 Lackawanna Ave., Mayfield, Pa.
United Mask & Novelty Co., Inc., Plastic Div., 70-02 70th Ave., Glendale, L.I., N.Y.
United Merchants Industrial Fabrics, Div., Davis Mills Corp., 1047 Broadway, New York 18, N.Y.
United Sales Service, 6762 Colgate Ave., Los Angeles 48, Calif.
•United States Gasket Co., 602 N. 10th St., Camden 1, N.J.
United States Glass Fiber Co., 148 Forest St., Manchester, Conn.
•United States Gypsum Co., 300 W. Adams St., Chicago 6, Ill.
•United States Industrial Chemicals Co., Div. National Distillers & Chemical Corp., 99 Park Ave., New York 16, N.Y.
United States Industries, Inc., Axelson Mfg. Co. Div., 6160 S. Boyle Ave., Los Angeles 58, Calif.
United States Metal Coatings Co., Inc., 701 Spring St., Elizabeth 4, N.J.
United States Plastic Molding Corp., Carlton St., Wallingford, Conn.
United States Plastic Products Corp., Box 49, Metuchen, N.J.
United States Plywood Corp., 55 W. 44th St., New York 18, N.Y.
•United States Polymeric Chemicals, Inc., Box 507, Stamford, Conn.
•United States Rubber Co., 407 N. Main St., Mishawaka, Ind.
•United States Rubber Co., 1230 Ave. of the Americas, New York, N.Y.
•United States Rubber Co., Chicago Die Mold Div., 4001 W. Wrightwood Ave., Chicago 39, Ill.
•United States Rubber Co., Naugatuck Chemical Div., 203 Elm St., Naugatuck, Conn.
•United States Rubber Co., Royalite Plastic Products, 2638 N. Pulaski Rd., Chicago 39, Ill.
U.S. Steel Co., 525 William Penn Pl., Pittsburgh, Pa.
United States Stoneware Co., Tallmadge Ave., Box 350, Akron 9, Ohio
United States Testing Co., Inc., 1415 Park Ave., Hoboken, N.J.
United Tool Co., 170 Bennett, Bridgeport 5, Conn.
Universal Aviation Corp., 85 Beechwood Ave., New Rochelle, N.Y.
Universal Hydraulic Machinery Co., Inc., 285 Hudson St., New York 13, N.Y.
Universal Moulded Products Corp., Commonwealth Ave., Bristol, Va.
Universal Molding, Inc., 535 N. Keller St., Upper Sandusky, Ohio
Urrite Plastics Fabricators, 4740 S. Durfee Rd., Pico, Calif.
Utility Mfg. Co., 4758 S. Kingan Ave., Cudahy, Wis.

V

V. & O Press Co., Hudson, N.Y.
Vac-Art, Inc., 2661 Broadway, Box 211, Bay City, Mich.
Vacu-Form Corp. of America, 426 Union Ave., Brooklyn, N.Y.
Vacumet, Inc., 1009 W. Weed, Chicago 22, Ill.
Vacuum Coatings, Inc., Depot St., Wilkinsonville, Mass.
Vacuum Forming Corp., 76 S. Bayles Ave., Port Washington, N.Y.
Vacuum Metalizing Corp., 32-36 Greenpoint Ave., L.I.C. 1, N.Y.
• Vacuum Plastics Corp., 1096 Scott St., Columbus, Ohio
Vacuum Sales Co., 290 Broadway, Huntington Station, L.I., N.Y.
•Valite, Div. Valentine Sugars, Inc., 726 Whitney Bldg., New Orleans 12, La.
Valley-National Corp., The, Clark St., Milldale, Conn.
Van Cleef Bros., Inc., Div. Johns-Manville, 7800 Woodlawn Ave., Chicago 19, Ill.
Van Cleef & Co., P.O. Box 247, Branford, Conn.
Van Doren, Harold, 1717 Sansom St., Phila. 3, Pa.
•Van Dorn Iron Works Co., The, 2685 E. 79th St., Cleveland 4, Ohio
Van Ness Plastic Molding Co., 327 Main St., Belleville 9, N.J.
Van Norman Machine Co., 3640 Main St., Springfield 7, Mass.
Van Norman Molding Co., 4631 Cottage Grove Ave., Chicago 15, Ill.
Van Wyck Products Co., Inc., 385 E. Green St., Pasadena 1, Calif.
Vanderbilt, R. T. Co., Inc., 230 Park Ave., New York 17, N.Y.
Vansul Sales Co., 183 William St., Englewood, N.J.
Vapor Blast Mfg. Co., 2025 W. Atkinson Ave., Milwaukee 16, Wis.
Vapor Heating Corp., 80 E. Jackson Blvd., Chicago 4, Ill.
Varcum Chemical Corp., Packard Rd., Niagara Falls, N.Y.
Vargish & Co., Inc., 3860 Park Ave., Bronx 57, N.Y.
Varney Inc., 3950 N.W. 28th St., Miami 42, Fla.
Vaupell Plastics, 1150 W. 53rd St., Seattle 7, Wash.
Vavrik, Louis, Industrial Design, 634 Dixie Highway, Rossford, Ohio
Velsicol Chemical Corp., 330 E. Grand Ave., Chicago 11, Ill.
Velveray Corp., 15 W. 34th St., New York 1, N.Y.
Venango Plastics, Inc., Box 368, Franklin, Pa.
Verduin, John Machine Corp., 351 Tenth Ave., Paterson 4, N.J.
Vern Emery Co., 10647 Wixom St., Sun Valley, Calif.
Vernon-Benshoff Co., P.O. Box 1587, Pittsburgh 30, Pa.
Verson Allsteel Press Co., 1355 E. 93rd St., Chicago 19, Ill.
Vertrod Corp., 2037 Utica Ave., B'klyn 7, N.Y.
Vic Mfg. Co., 1313 Hawthorne Ave., Minneapolis 3, Minn.
•Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.
Victor Kellering, Inc., 955 E. 51st St., B'klyn 3, N.Y.
• Victory Mfg. Co., 1720-42 W. Arcade Pl., Chicago 12, Ill.
Victory Plastics Co., 81 Apsley St., Hudson, Mass.
Viking Pump Co., 4th & Dyson Sts., Cedar Falls, Iowa
Vinylcards, Inc., 224 E. 8th St., Cincinnati 2, Ohio
Virginia Plak Co., 270 Madison Ave., New York 16, N. Y.
Virginia-Carolina Chemical Corp., 401 E. Main St., Richmond 5, Va.
Visking Corp., 6733 W. 65th St., Chicago, Ill.
Vitro Engineering Div., Vitro Corp. of America; 1025 Connecticut Ave., Washington 6, D. C.
Vitro Mfg. Co., 60 Greenway Dr., Pittsburgh, Pa.
Vichek Tool Co., The, 3001 E. 87th St., Cleveland 4, Ohio
Vogel Mfg. Co., The, 506 Logan St., Bridgeport 1, Conn.
Voges Mfg. Co. Inc., 103-11 98th St., Ozone Park 17, N. Y.
• Vogt Mfg. Corp., Plastics Div. 100 Fernwood Ave., Rochester 21, N. Y.
Voliet Plastic, Inc., 15 South Joliet St., Joliet, Ill.
Vulcan Rubber Products, Inc., Sub. of Reeves Brothers Inc., 54 Worth St., New York, N. Y.
Vulcan Tool Co., The, 730 Lorain Ave., Dayton 10, Ohio
Vulcanized Rubber & Plastics Co., 5 S. Pennsylvania Ave., Morrisville, Pa.

W

W. & A. Co., Inc., 56 Union St., Attleboro, Mass.
W-L Molding Co., The, 8212 U. S. Hwy. 131 S. Kalamazoo, Mich.
Wabash Fibre Box Co., 2000 N. 19th St., Terre Haute, Indiana.
Wabash Metal Products Co., Box 305, 1569 Morris St., Wabash, Ind.
Wachter Plastic Co., 727½ J. St., Sacramento 14, Calif.
Wagner, Charles A. Co., Inc., 4455 N. 6th St., Philadelphia 40, Pa.
Wagner Mfg. Co., Inc., 350 W. Adams St., Jackson, Mo.
Wagner Plastic Corp., 6500 Hudson Blvd., W. New York, N. J.
Wait-Plastics, 4515 Page Ave., Jackson, Mich.
Wal-Mar Plastics, Inc., 21805 Western Ave., Torrance, Calif.
Walden Inc., 919 N. Michigan Ave., Chicago, Ill.
• Waldron, John Corp., P. O. Box 791, New Brunswick, N. J.
•Waljohn Plastics, Inc., 437-88 St., B'klyn. 9, N. Y.

•Indicates Advertiser.

● Wallace & Tiernan, Inc., Harchem Div., 25 Main St., Belleville 9, N. J.
● Wallace & Tiernan, Inc., Lucidol Div., 1740 Military Rd., Buffalo 5, N. Y.
Wallace Container Co., 627 E. Washington Ave., Santa Ana, Calif.
Waltco Products, 4501 S. Western St., Chicago 9, Ill.
Wama Co., Industrial Bldg. Baltimore 2, Md.
Warren Plastics Corp., S. Irvine St., Warren, Pa.
● Warwick Chemical Co., Sun Chem. Div., 10–10 44th Ave., L. I. C. 1, N. Y.
Wasco Products, Inc., Bay State Rd., Cambridge, Mass.
Washburn, T. F., Co., 2244 Elston Ave., Chicago, Ill.
Washington Plastics Co., 1140 George St., Sharon, Pa.
● Waterbury Companies, Inc., 835 S. Main St., Waterbury 20, Conn.
● Watertown Mfg. Co., The 1000 Echo Lake Rd., Watertown, Conn.
● Watlow Electric Mfg. Co., 1376 Ferguson Ave., St. Louis 14, Mo.
● Watson Standard Co., 225 Galveston Ave., Pittsburgh 12, Pa.
● Watson-Stillman Press Div., Farrell-Birmingham Co. Inc., 156 Aldene Rd., Roselle, N. J.
Wayne Plastics Corp., 2330 Dwenger Ave., Ft. Wayne, Ind.
Weber, H. L. & Co. Inc., Kiel, Wis.
Weber, J., Mfg. Corp., The, 2 East 54th St., New York 22, N.Y.
Weber Plastics, Inc., 133 W. Ellis St., Stevens Pt., Wis.
Weblon, Inc., 11 W. 42nd St., New York 36, N. Y.
Weckesser Co., 5265 N. Avondale Ave., Chicago, Ill.
Wecolite Co., 552 W. 53rd St., New York, N. Y.
Weighing Components, Inc., 64 Fulmor Ave., Hatboro, Pa.
Weiss & Klau Co., 462 Broadway, New York 13, N. Y.
Weiss, A. L. Co., 150 20th St., Brooklyn, N. Y.
Welch Plastics & Mfg. Co., Inc., 814 W. Third Ave., Columbus 8, Ohio
Weld Edge Plastics, Inc., 270 Ferry St., Newark 5, N. J.
● Welding Engineers, Inc., P. O. Box 391, Norristown, Pa.
Wellington Print Works, Inc., Lalor & Hancock St., Trenton, N. J.
● Wellington Sears Co., Inc., 65 Worth St., New York 13, N. Y.
Wessel, Stanley & Co., 420 N. Michigan Ave., Chicago 11, Ill.
West Coast Plastics Distributors, Inc., 8510 Warner Dr., Culver City, Calif.
West & East Trading Corp., 32 Broadway, New York, N. Y.
● West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
● Westchester Plastics, Inc., 326 Waverly Ave., Mamaroneck, N. Y.
Western Coating Co., P. O. Box 109, Elyria, Ohio
Western Coating Co., 85 W. Union St., Pasadena 1, Calif.
Western Coating Co., P. O. Box 598, Oakridge Station, Royal Oak, Mich.
Western Coil & Electrical Co., 215 State St., Racine, Wis.
Western Felt Works, 4115 Ogden Ave., Chicago 23, Ill.
Western Plastic & Rubber Co., 1101 Wright Ave., Richmond, Calif.
Western Plastic Inc., E. 802 Pacific Ave., Spokane 3, Wash.
Western Plastics Corp., 3110 Ruston Way, Tacoma 2, Wash.
Western Plastics Corp., 1515 W. 2nd St., Hastings, Neb.
● Western Supplies Co., 2920 Cass Ave., St. Louis 6, Mo.
Westinghouse Air Brake Co., Industrial Products Div., Wilmerding, Pa.
Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.
Westinghouse Electric Corp., Micarta Div., Hampton, S. C.
Westlake Plastics, West Lenni Rd., Lenni Mills, Pa.
Westland Plastics, Inc., 3317 E. Pico Blvd., Los Angeles 23, Calif.
Westmoreland Plastics Co., 135 Gertrude St., Latrobe, Pa.
Weston Electrical Instrument Corp., Sub., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.
Westplex Corp., 12 Commercial St., Rochester 14, N. Y.
Westvaco Chlor-Alkali Div., Food Machinery & Chemical Corp., 161 E. 42 St., New York 17, N.Y.
Westvaco Mineral Products Div., Food Machinery & Chemical Corp., 161 E. 42 St., New York 17, N. Y.
Wexler, S. & Co., 44 W. Cermak Rd., Chicago 16, Ill.
Weyerhauser Sales Co., 1st Natl. Bank Bldg., St. Paul 1, Minn.
Weyerhauser Timber Co., Special Products Div., P. O. Box 1645, Tacoma, Wash.
Wharry, G. A. & Co., Inc., 125 Broad St., New York 4, N. Y.
Wheaton, T. C. Co., Mays Landing, N.J.
Wheelabrator Co., 837 S. Byrkit St., Mishawaka, Inc.
● Wheelco Instrument Co., Div. Barber-Colman Co., 1533 Rock St., Rockford, Ill.
Wheeling Stamping Co., 2110 Water St., Wheeling, W. Va.
White, S. S. Dental Mfg. Co., The, 10 E. 40th St., New York 16, N. Y.
● Whitlock, C. H. Assoc., 21655 Coolidge Hwy., Oak Park 37, Mich.
Whitlock Co., The, 3655 N. Southport Ave., Chicago 13, Ill.
Whitman Plastics Corp., 363 Highland Ave., Somerville 44, Mass.
Whitney Chain Co., The, Hansom-Whitney Co., Div., 175 Bartholomew St., Hartford 2, Conn.
Whitso, Inc., 9330 Byron St., Schiller Park, Ill.
Whittaker, Clark & Daniels, Inc., 260 West Broadway, New York 13, N. Y.
Whyte Mfg. Co. Inc., 113 4th Ave., New York 3, N. Y.
● Wiegand, Edwin L. Co., 7613 Thomas Blvd., Pittsburgh 8, Pa.
Wiggins Plastic Molding Co., 10 Kingsland Rd., Clifton, N. J.
Wiggins Plastic Molding Co., Inc., 317 Cortlandt St., Belleville 9, N. J.
Wilco Co., 4425 Bandini Blvd., Los Angeles 23, Calif.
Wilcox Plastics, Inc., 656 Vail Ave., Montebello, Calif.
● Williams-White & Co., 800 Third Ave., Moline, Ill.
Williamson Adhesives, Inc., 8220 Kimball Ave., Skokie, Ill.
Wills, John A. & Co., 2941 Doyne Rd., Pasadena 8, Calif.
Willson Camera Co., Inc., 1395 Lawrence Rd., Havertown, Pa.
Wilmington Fibre Spec. Co., New Castle, Del.
Wilmot & Cassidy, Inc., 108 Provost St., B'klyn. 22, N. Y.
Wilner Wood Flour Co., Norway, Maine
Wilpet Tool & Mfg. Co., 244 Dukes St., Kearney, N. J.
Wilross Products Co., 20 4th Ave., Hawthorne, N. J.
Wilson Plastics Inc., MacArthur Ave., New Windsor, N. Y.
Wilson Plastics, Inc., 1531 Milan Rd., Sandusky, Ohio
Wilson Plastics of Fla., Inc., 5701 W. Beaver St., Jacksonville 5, Fla.
Wilson, Ralph Plastics, Inc., Temple, Texas
Windman Bros., 3325 Union Pacific Ave., Los Angeles 23, Calif.
● Windsor, R. H. Ltd., Leatherhead Rd., South Chessington, Surrey, England
Winner Mfg. Co., Inc., Box 399, Trenton, N. J.
Wirz, A. H., Inc., Fourth & Darlington Sts. Chester, Pa.
● Witco Chemical Co., 122 E. 42 St., New York 17, N. Y.
Witte, John H, & Sons, 206 Jefferson St., Burlington, Iowa
Wizard Boots, Inc., 2075 Harbor Blvd., Costa Mesa, Calif.
● Woloch, George Co., Inc., 601 W. 26th St., New York, N. Y.
Wolverine Equipment Co., 31 Main St., Cambridge, Mass.
Wolverine Paper Converting Machinery Corp., 18584 Fitzpatrick, Detroit 28, Mich.
Wood Flour, Inc., Howard St., Winchester, N. H.
● Wood, R. D. Co., 1072 Public Ledger Bldg., Phila. 5, Pa.
Woodall Industries, Inc., 7575 E. Mc Nichols Rd., Detroit 34, Mich.
Worbla Ltd., Papiermuhle-Bern, Switzerland
Worcester Moulded Plastics Co., 14 Hygeia St., Worcester 8, Mass.
World Plastex, 1685 Boone Ave., New York 60, N. Y.
● Wrenn Paper Co., The, First & Water Sts., Middletown, Ohio
Wyandotte Chemicals Corp., 1609 Biddle Ave., Wyandotte, Mich.
Wyatt's Plastics, Inc., 5928 Katy St., Houston, Texas
Wyndmoor Mfg. Corp., 1000 Roosevelt Ave., Carteret, N. J.
Wynnewood Products Co., 303 Tena St., P. O. Box 1088, Jacksonville, Texas
Wysong & Miles Co., 625 Fulton St., Greensboro, N. C.
Wyssmont Co., Inc., 42–05 27th St., L.I.C. 1, N. Y.
Wyzenbeek & Staff, Inc., 223 N. California Ave., Chicago 12, Ill.

X

Xylos Rubber Co., Div., Firestone Tire & Rubber Co., P. O. Box 2727, Akron 1, Ohio

Y

● Yardley Plastics Co., 142 Parsons Ave., Columbus 15, Ohio
Yates Co., 2211 Peninsula Dr., Erie, Pa.
Yates-American Machine Co., 729 4th St., Beloit, Wis.

● Indicates Advertiser.

Yorker & Sons, Inc., 601–03 E. 48th Ave., Denver 16, Colo.
Young Machinery Co., R. D. 2, Muncy, Pa.
Youngstown Miller Corp., Box 70, Norwalk, Ohio

Z

Zack Industries, 185 Goffle Rd., Hawthorne, N. J.

● Indicates Advertiser.

● Zapf, Charles & Co., 2423 Main St., Evanstown, Ill.
Zenith Plastics Co., 3901 Superior Ave., Cleveland, Ohio
Zenith Plastics Co., Div., Zenith Aircraft, P. O. Box 91, 1600 W. 135th St., Gardena, Calif.
Zenith Plastic Co., 9 S. Adams St., Ypsilanti, Mich.
Zenner, Justin, 823 E. Waveland Ave., Chicago 13, Ill.
Zimmer, Hans J., Frankfurt-am-Main, Germany
Zimmerman Co., Plastex Co., Div., 3232 Cleveland Ave., Columbus, Ohio
Zinnser & Co., Inc., Hastings-on-Hudson, N. Y.
Zinsser, William & Co., Inc., 516 W. 59th St., New York 19, N. Y.
Zip Abrasives Corp., 1360 W. Ninth St., Cleveland, Ohio
● Zollinger, Albert Inc., 1245 Warren Ave., Downers Grove, Ill.

"Please recommend a material which will . . . "

"Our need is a plastic wheel that . . . "

"Do you know of a manufacturer who . . . ?"

" . . . and how can we insulate it?"

"Who makes stock molded cookie cutters?"

"Where can I purchase a machine that . . . ?"

Each month the Readers' Service Department of MODERN PLASTICS answers scores of questions for our readers. Questions range from simple requests for information about the manufacturer of a stock molded item to requests which must be referred to industry sources for action.

With their extensive files, reference library and wide knowledge of plastics materials, machinery and procedure, the members of the Readers' Service Department can usually supply, or refer you to someone who can supply, the information you want.

If you have a question, feel free to forward it. There is no charge or obligation for this service. Address—Readers' Service Department, MODERN PLASTICS. A complete reply to your inquiry will be sent promptly.

MODERN PLASTICS

A Breskin Publication

575 Madison Avenue New York 22, N. Y.

Advertisers' index

Modern Plastics Encyclopedia Issue — September 1957

Abbe, Paul O., Inc. 912
Ace Plastic Company 770, 857
Acheson Dispersed Pigments Co. 417
Ackerman-Gould Company 863
Acme Resin Corporation 184
Acromark Company, The 840
Adamson United Company 930, 931
Admiral Corporation, Molded Products Division 777
Advance Solvents & Chemical, Division of Carlisle Chemical Works, Inc. 414
Aetna Electronics Corp. 997
Aetna-Standard Engineering Co., The 877
Akron Presform Mold Co., The 929
Allied Chemical & Dye Corporation .....
Barrett Division 209–212, 416
National Aniline Division 398–399
Plaskon, Barrett Division 552
Semet-Solvay Petrochemical Division 331
Ambassador Plastics & Mfg. Corp. 362
American Agile Corporation 974
American Cyanamid Company,
Dyes Department 388
Pigments Division 389
Plastics & Resins Division 215–230
American Insulator Corporation 648
American Molding Powder & Chemical Corporation 272
American Steel Foundries, Elmes Engineering Division 938, 939
Amos Molded Plastics 787
Anchor Plastics Co., Inc. 805
Angier Adhesives, Division of Interchemical Corp. 238
Anson Tools & Gages, Inc. 978
Antara Chemicals, Div., General Aniline & Film Corp. 395
Apex Machine Company 862
Applied Radiation Corporation 973
Archer-Daniels-Midland 395
Argus Chemical Corporation 431
Artag Plastics Corporation 625
Atlas Coatings Corporation 458
Atlas Electric Devices Co. 912
Atols Tool and Mold Corporation 643
Auburn Plastics, Inc. 808
Automatic Molding & Machine Company 883

Badische Anilin- &Soda-Fabrik AG. 402B
Bailey, R.N., & Co., Inc. 925
Bakelite Co., Division of Union Carbide Corp. 259–270
Barber-Colman Company 984
Barrett Division, Allied Chemical & Dye Corp. 209–212, 416
Barron, J. E., Plastics, Inc. 257
Battenfeld 881
Becker & Van Hullen 963
Belding Corticelli Industries 325
Bestwall Certain-Teed Sales Corporation 328
B. I. P. Engineering, Ltd. 960
Black-Clawson Company, The Dilts Division 981
Blackhawk Molding Co., Inc. 808
Bolling, Stewart, & Co., Inc. 868
Boonton Molding Co. 634
Borco Chemicals Inc. 422
Borg-Warner, Marbon Chemical Division 291
Brenner, I. G., Co. 910
Brosites Machine Company Inc. 911
Brown Company 484
Brown-Allen Chemicals, Inc. 400
Brunswick-Balke-Collender Company, The 499
Budd Company, The Continental-Diamond Fibre Subsidiary 541–544
Busada Mfg. Corp. 770
Buss Machine Works 981
Butterfield, T. F., Inc. 810
Byrd Plastics, Inc. 759

Cabot, Godfrey L., Inc., Minerals & Chemicals Division 397
Cadillac Plastic and Chemical Co. 47
Cambridge Instrument Co., Inc. 972
Carlisle Chemical Work, Inc., Advance Solvents & Chemical Div. 414
Carlon Products Corporation 757
Carmer Industries 812C
Carroll, J. B., Company 842
Carver, Fred S., Inc. 914, 915
Cast Optics Corporation 452
Catalin Corp. of America 303
Celanese Corporation of America,
Chemical Division 408, 409
Plastics Division 321–324
Chemical Products Corporation 42
Chemische Werke Huls Aktiengesellschaft 402A
Chemore Corporation 271
Chicago Mold Engineering Co. Incorporated 768
Chicago Molded Products Corp., Campco Division 456
Chili Plastics, Inc. 776
Chromium Corporation of America 805
Ciba Co. Inc.
Dyestuff 491, 492
Plastics Division 273–276
Cincinnati Milling Machine Co., The 866
Claremont Pigment Dispersion Corp. 415
Claremont Waste Mfg. Co. 489
Clifton Hydraulic Press Co. 928
Coast Manufacturing & Supply Company 488
Coating Products 466
Colonial Kolonite Co. 844
Columbian Carbon Company 407
Commercial Plastics Co. 815
Commercial Plastics and Supply Corp. 460
Comet Industries 874

Como Plastics, Inc. 813
Conforming Matrix Corp. 853
Connecticut Plastic Products Company 646
Consolidated Molded Products Corporation 807
Continental-Diamond Fibre, Subsidiary of the Budd Company 541-544
Contour Extrusion Company 781
Cook, Lawrence H., Inc. 805
Cordo Molding Products, Inc. 483
Cosmos Electronic Machine Corp. 991
Cosom Engineering Corporation 854
Covena-Bendera (GBF) 997, 1002
Crescent Plastics, Inc. 755
Cumberland Engineering Company Inc. 875
Curtiss-Wright Corporation, Electronics Div. 998
Custom Engineering Co. 978
Custom Machine & Design, Inc. 952
Cylinder Mfg. Co. 978

D & R Plastic Welders, Inc. 850
Dake Corporation 876
Daniels, T. H., & J., Ltd. 974
Danielson Manufacturing Co., Subsidiary of Nickolson File Co. 783
Davidson-Kennedy Co. 982
Davies, Harry, Molding Company 639
Davis, Joseph, Plastics Company 461
Davis-Standard Div., Franklin Research Corp. 888
Decar Plastic Corporation 550
Deecy Products Co. 420
DeMattia Machine And Tool Co. 988
Desert Sunshine Exposure Tests 760
Detroit Mold Engineering Co. 645
Detroit Stamping Co. 980
Detroit Macoid Corporation 816
DeVilbiss Company, The 362, 992
Diamond Alkali Company
Calcium Carbonates Plastics 490
Chlorowax Division 401
Plastics Division 302
Diemolding Corporation 768
Dillon-Beck Manufacturing Co. 644
Dilts Division, The Black-Clawson Company 981
Doven Machine & Engineering Co. 936
Douglas Aircraft Co., Inc., Aircomb Section 548
Dow Chemical Company, The, Plastics Sales Dept. ... 49-56
Drakenfeld, B. F., & Co., Inc. 420
Dunning & Boschert Press Co., Inc. 949
du Pont de Nemours, E. I., & Co. (Inc.),
Chemical Sales, Explosives Department 361
Electrochemicals Dept. 396
Polychemicals Department 65-84
Durez Plastics Division, Hooker Electrochemical Company 43-46, 300, 301
Dusenbery, John, Co., Inc. 995
Dynamit-Actien-Gesellschaft 207

Eagle-Picher Company, The, Fabricon Products Division 549
Eagle Tool and Machine Co. 759
Eastman Chemical Products, Inc. 326, 327
Eastman Kodak Company, Cellulose Products Division 455
Egan, Frank W., & Company 884
Electric Auto-Lite Company, The, Instrument and Gauge Division 949
Electro-Technical Products Division of Sun Chemical Corp. 501
Electromold Corp. 812
Elmes Engineering Division, American Steel Foundries 938, 939
Emeloid 793
Emery Industries, Inc. 421
Engelking Patterns, Inc. 630
English Mica Co., The 500
Enjay Company, Inc. 403-406
Entoleter Division, Safety Industries Inc. 954
Erdco Engineering Corp. 916
Erie Engine & Mfg. Co. 989
Erie Foundry Co. 886
Erie Plastics Co., Inc. 278
Erie Resistor Corporation, Erie Plastics Division 809
Escambia Chemical Corp. 305
Exeter Manufacturing Company, Industrial Glass Cloth Division 537

Fabrico Manufacturing Corp. 862
Fabricon Products, Division, The Eagle-Picher Company 549
Faeco Machine Company 952
Falls Engineering and Machine Co., The 972
Farrel-Birmingham Company, Inc., Watson-Stillman Press Division 950, 951
Federal Tool Corporation 776
Fellows Gear Shaper Company, The, Plastics Machine Division 996
Ferro Corporation
Color Div. 393, 394
Fiber Glass Div. 497, 498
Fiberfil, Inc. 293-296
Fiberite Corporation, The 208
Fierstone Plastics Company, Chemical Sales Division 202, 203
Fine Organics, Inc. 413
Finish Engineering Co., Inc. 862
Fiore, Wm. M., Inc. 843
Flick-Reedy Corporation, Miller Fluid Power Division 994
Flightex Fabrics, Inc. 504
Food Machinery & Chemical Corporation, Ohio Apex Division 330
Forrest Manufacturing Company, Inc. 842
Foster & Allen, Inc. 916
Foster Grant Co., Inc., Petrochemical Division 201
Fostoria Pressed Steel Corp. 913
Franklin Research Corp., Davis-Standard Div. 888
French Oil Mill Machinery Co., The, Hydraulic Press Division 985
Furane Plastics Inc. 320

Gane Brothers and Lane, Inc. 861
Geissel Mfg. Co., Inc. 636
General American Transportation Corporation,
Lincoln Molded Plastics, Inc., Subsidiary 636
Parker-Kalon Division 848, 849
Plastics Division 771-774
General Aniline & Film Corporation, Antara Chemicals Div. 395
General Die Mold Co. 776
General Dyestuff Company Div. 400
General Electric Company, Chemical Materials Dept. 188, 189
General Industries Co., The 623, 662
General Plastics Corporation 646
General Roll Leaf Manufacturing Co. 858
General Tire & Rubber Company, The, Chemical Division 318-319

Gering Products, Inc. 317
Gilman Brothers Company, The 464
Glass Yarns & Deeside Fabrics Ltd. 534
Glenn Electric Heater Corporation 953
Glidden Co., The,
Chemicals-Pigments-Metals Div. 428
Industrial Finishers Div. 213
G. M. C. Process Corp. 857
Goodrich, B. F., Company, The, Geom Div. 279–290
Goodyear Tire & Rubber Company, The,
Chemical Division 233–236
Gorton, George, Machine Co. 1016
Grace, W. R., & Co., Polymer Chemicals Division .. 306, 307
Great American Plastics Company, Petro
Chemical Division 308
Grimes Manufacturing Company, Plastic Research
Products Company Division 799

Hale & Kullgren, Inc. 877
Harchem Division, Wallace & Tiernan, Inc. 419
H & R Industries 447, 769
Hardman, H. V., Co., Inc. 948
Harshaw Chemical Co., The 410, 411
Hartig Extruders 948
Harwick Standard Chemical Co. 390
Hawley Products Company 529
Hayden Mica Co. 504
Hexcel Products Inc. 528
HMS Associates 814
Hobbs Manufacturing Co. 992, 1014
Hofmann & Schwabe K. G. 882
Holland, M., Company 258
Hommel, O., Co., The, Pigment Division 402
Honolulu Oil Company, Industrial Research
Laboratories Div. 1015
Hooker Electrochemical Co., Durez
Plastics Division 43–46, 300, 301
Hopp Press, Inc., The, Hopp Plastics Division 856
Hull Standard Corporation 955
Hurlbut Paper Company 545
Hyde, A. L., Co. 812
Hydraulic Press Mfg. Co., The, Division of
Koehring Co. 878, 879

Ideal Plastics 628
Imperial Chemical Industries Limited, Plastics
Division 232
Improved Machinery Inc. 1013
Industrial Heater Co., Inc. 992
Industrial Mfg. Corp. 932
Industrial Molded Products Co., Inc. 767
Industrial Ovens, Inc. 962
Industrial Research Laboratories, Division of
Honolulu Oil Company 1015
Industrial Solvents & Chemicals, Inc. 430
Injection Molders Supply Co. 867, 961
Insulation Mfg. Company, Inc. 816
Interchemical Corporation, Angier Adhesives Div. 238
Interplastics Corporation 278
Irvin, Jewell & Vinson Co., The 863

Jay, T. V., Company 788
Johnson Glass & Plastic Corp. 760
Johnson Machinery Co. 954
Johnson Manufacturing Company 811

Karlton Machinery Corporation, Becker &
Van Hullen 963

Kentucky Color and Chemical Company, Inc. 395
Keolyn Plastics 766
Killion Tool & Mfg. Co. 923
Kingman, E. B., Co., Inc. 788
Kingsley Stamping Machine Co. 861
Koppers Company, Inc., Chemical Division 253–256
Kramer, H. W., Co. 852
Krieger Color & Chemical Co., Inc. 420
Kuhn & Jacob Molding & Tool Co. 649
Kurz-Kasch, Inc. 633

Lake Erie Machinery Corp. 999
Laminations, Inc. 540
Leaf Plastics Incorporated 642
Larc Products Inc. 466A
Lawton, C. A., Company, The 1006
Lehmann, J. M., Company, Inc., Wm. R. Thropp &
Sons Div. 1004
Lemmon and Snoap 995
Lester-Phoenix, Inc. 880
Lewis Welding & Engineering Corp., The,
Machine Division 1007
Liberty Cutting Die Company 948
Liberty Machine Co., Inc. 917
Liberty Tool & Machine Co. 792
Lincoln Molded Plastics, Inc., Subsidiary of
General American Transportation Corp. 636
Litzler, C. A., Co., Inc. 921
Lodge & Shipley Co., The 1008
Logan Hydraulics, Inc. 937
Logo, Inc., Division BWE Chemical Co. 858
Lombard Governor Corporation 958
Lor-El Company 766
Lucidol Division, Wallace & Tiernan Incorporated 418
Luminous Resins Incorporated 85
Lupoline Automatic Polishing Equipment Corporation... 857
Lydon Bros., Inc. 1014

M & N Modern Hydraulic Press Co. 1004
Mack Molding Company, Inc. 640
Makray Manufacturing Company 631
Marblette Corporation, The 63, 780
Marbon Chemical, A Division of Borg-Warner 291
Marvel Engineering Company 933
Matthews, Jas. H. & Co. 858
Mayer Refrigerating Engineers, Inc. 1016
Mayflower Electronic Devices, Inc. 1014
McKesson & Robbins, Inc., Chemical Department 430
Mearl Corporation, The 392
Merck & Co., Inc., Chemical Division 400
Mercury Industries Inc. 964
Metal & Thermit Corporation 432
Metals Disintegrating Company, Inc., Pulverizing
Machinery Div. 986
Michigan Chrome and Chemical Company 278
Michigan Plastic Products, Inc. 643
Mico Instrument Co. 995
Micron Specialties, Inc. 644
Midland Die & Engraving Division, Prex Corporation ... 803
Midwest Molding and Manufacturing Company 792
Midwest Plastic Products Company 797
Miller Fluid Power Division, Flick-Reedy Corp. 994
Mimosa Corporation 785
Minerals & Chemicals Corporation of America 496
Minnesota Plastics Corp. 627
Modern Plastic Machinery Corp. 885
Modiglass Fibers, Inc. 504
Molded Products, Division of Admiral Corporation 777

Mono-Sol Corp. 458
Monsanto Chemical Company
Organic Chemicals Division 59–62
Plastics Division 239–250
Morart Gravure Corp., Marart-Oxford Corp. 535
Morningstar Corporation, The 797
Mosinee Paper Mills Co. 485
Moslo Machinery Company 1001
Muehlstein, H., & Co., Inc. 252, 277
Mycalex Corporation of America 204, 205

Nash, J. M., Company 845
National Aniline Div., Allied Chemical & Dye Corp. 398–399
National Distillers & Chemical Corp., U. S. Industrial Chemicals Co. Div. 186–187
National Plastics (Sales) Limited 000
National Plastic Products Company, The, Molding Div. 792
National Polymer Products, Inc. 251
National Research Corporation, NRC Equipment Corporation Subsidiary 850
National Rubber Machinery Company 869–872
National Vulcanized Fibre Co. 538, 539
Naugatuck Chemical Div., United States Rubber Co. 191–200
Negri Bossi & Co. 966
Newark Die Hobbing and Casting Co. 765
Newbury Industries Inc. 945
New England Laminates Co., Inc. 550
New Hermes Engraving Machine Corp. 991
Niagara Machine & Tool Works 959
Nickolson File Co., Danielson Manufacturing Co. Subsidiary 783
Nixon Nitration Works 459
Northwest Plastics, Inc. 629
Norton Laboratories, Inc. 801
Nutmeg Chrome Corporation 794

Ohio-Apex Division, Food Machinery and Chemical Corp. 330
Olsenmark Corporation 841
Omni Products Corporation 292
Orange Products, Inc. 861
Owens-Illinois 632

Pantex Mfg. Corp. 991
Paragon Molding Co. 762
Parker-Kalon Div., General American Transportation Corporation 848, 849
Parkwood Laminates, Inc. 547
Peco Machinery Sales (Westminster) Limited 990
Peerless Roll Leaf Co., Inc. 855
Penn-Plastics Corporation 814
Perforating Industries, Inc. 458
Perry Plastics, Inc. 806
Peters Chemical Manufacturing Co. 320
Peterson, A. W., & Sons Die Company, Inc. 812B
Phillips Chemical Company, Plastics Sales Division 297, 304
Pittsburgh Coke & Chemical Co., Industrial Chemicals Division 423–426
Pittsburgh Plate Glass Company,
Fiber Glass Division 495
Selectron Products Division 190
Plaskon, Barrett Division, Allied Chemical & Dye Corporation 552
Plastex Company, The 635
Plastic Molders Supply Co., Inc. 392
Plastic Molding Corp. 794
Plastics Horizons, Inc., Raritan Plastics Corp., Div. 449
Plastic Research Products, Co., Division of Grimes Manufacturing Company 799
Plastic Stamping & Molding Corp. 852
Plasticrafts Inc. 761
Plastics Color Company 429
Plastics Engineering Company 332
Plas-Tube 813
Plating Engineering Co. 798
Plaxall, Inc. 789
Plura Plastics 798
Plymouth Fibres Co., Inc. 486
Polygon Plastic Company 550
Polymer Corporation, The 206
Polyplastics United Inc. 502
Portage Plastics Co., Inc. 453
Powers Regulator Co., The 920
Port Erie Plastics, Inc. 800
Powhatan Mining Company 494
Precision Mold & Polishing Corporation 626
Presque Isle Plastics, Inc. 635
Prex Corporation, Midland Die & Engraving Division 803
Process Gear Co., Inc. 813
Prodex Corporation 946, 947
Production Metal Products Co., Inc. 980
Progressive Machine Co., Inc. 983
Projectile & Engineering Co., Ltd., The 990
Pulverizing Machinery Division, Metals Disintegrating Company, Inc. 986
Pyro Plastics Corporation 647

Quinn-Berry Corp. 791

Radio Receptor Company, Inc. 967
Raritan Plastics Corporation, Division of Plastic Horizons, Inc. 449
Rayon Processing Co., of R. I. 502
Recto Molded Products, Inc. 762
Reed Plastics Corporation 412
Reed-Prentice 976, 977
Reichhold Chemicals, Inc. 58, 231
Reifenhäuser, A. 987
Reliance Electric and Engineering Co. 944
Reliance Pattern Works 800
Resinoid Engineering Corporation 812B
Reynolds Chemical Products Company 812B
Richardson Company, The 546 638
Ringler-Dorin, Inc. 466A
Riverdale Color Co., Inc. 427
Robbins Plastic Machinery Corp. 968, 969
Roehlen Engraving Works, Inc. 448
Rogan Brothers 802
Rogers Corporation 237
Rohm & Haas Company 309–316
Rona Laboratories, Inc 413
Ross, Charles, & Son Co., Inc. 984
Rotuba Extruders, Inc., The, Division of Waljohn Plastics, Inc. 806

Royle, John & Sons 965
Rubber & Asbestos Corp. 214
Rubber Corporation of America 418

Safety Industries Inc., Entoleter Division 954
Sandee Manufacturing Company 812A
Sandman, Eli, Co. 501, 553
Santay Corporation 795
Sarco Company, Inc. 971
Schulman, A., Inc. 329
Schwab Plastics Corporation 794
Schwartz Chemical Co., Inc. 847
Scott Testers Inc. 952
Scranton Plastic Laminating Corp. 450
Sealomatic Electronics Corporation 926
Seiberling Rubber Company, Plastics Division 463
Semet-Solvay Petrochemical Division, Allied Chemical & Dye Corp. 331
Service Plastics, Inc. 784
Servospeed 763
Shaw, Francis, & Co., Ltd. 979
Shaw Insulator Company 802
Sheffield Plastics Inc. 648
Shell Chemical Corporation, Chemical Sales Div. 298
Sierra Electric Corp. 804
Sillcocks-Miller Company, The 846
Simplomatic Mfg. Co. 922
Sinclair-Collins Valve Company, The 1003
Sinko Mfg. & Tool Co. 802
Sobenite, Inc. 782
South Florida Test Service 804
Southern Plastics Co. 457
Spencer Chemical Company 48, 64
Sperry Rand Corporation, Vickers Incorporated Division 1009–1012
Standard Insulation Co. 500
Standard Molding Corporation 624
Standard Tool Company 922
Stanley Chemical Company 185
Sterling, Inc. 873
Stokes, F. J., Corporation 889
Stricker-Brunhuber Corp. 798
Stromes Systems, Inc. 975
Structurlite Plastics Corporation 536
Sullivan Chemicals Division, Sullivan Varnish Company 852
Sun Chemical Corporation, Electro-Technical Products Div. 501
Sunlite Plastics, Inc. 788
Superior Plastics Inc. 800
Swedlow Plastics Co. 532
Sylvania Electric Products Inc., Parts Division 775
Tungsten and Chemical Division 851
Synthetic Products Company 422

Taylor-Emmett Controls 956
Taylor Instrument Corporation 957
Taylor-Stiles & Co. 975
Thermel, Inc. 1005
Thermo Electric Co., Inc. 982
Thierica Studio 860
Thoreson-McCosh, Inc. 986
Tilp, J. G., Inc. 621
Transilwrap Company 465
Trans-Matic Plastics Company 810
Triulzi, Ambrogio, Off. 940, 941
Thropp, Wm., R., & Sons Division, J. M. Lehmann Company, Inc. 1002
Troy Blanket Mills 503
Tump-L-Matic, Inc. 855
Tupper Corporation 778, 779
20th Century Plastics Company 810

Union Carbide Corporation
Bakelite Company Div. 259–270
Union Carbide International Co. Div. 190A, 190B
United Laminations, Inc. 454
United States Gasket Co., Plastics Division 790
United States Gypsum Company 530, 531
U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp. 186, 187
U. S. Polymeric Chemicals, Inc. 553
United States Rubber Company,
Naugatuck Chemical Division 191–200
Royalite Division 462

Vacuum Plastics Corporation 804
Valite Corporation 308
Van Dorn Iron Works Co., The 887
Vickers Incorporated, Division of Sperry Rand Corp. 1009–1012
Victory Manufacturing Corp. 815
Vogt Manufacturing Corp. 764

Waldron, John, Corporation 942, 943
Waljohn Plastics, Inc. 812A
The Rotuba Extruders, Inc., Division 806
Wallace & Tiernan, Inc.
Harchem Division 419
Lucidol Division 418
Waterbury Companies, Inc. 641
Watertown Manufacturing Co., The 637
Watlow Electric Mfg. Co. 1000
Watson-Standard Co. 183
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. 950, 951
Welding Engineers, Inc. 993
Wellington Sears Co. 57, 493
Westchester Plastics, Inc. 299
Western Supplies Co 815
West Instrument Corporation 927
Whitlock, C. H., Associates 920
Wiegand, Edwin L., Company 970, 971
Williams-White & Co. 1000
Windsor, R. H., Ltd. 934, 935
Witco Chemical Company 391
Woloch, George, Co., Inc. 258
Wood, R. D., Company 918, 919
Wrenn Paper Co., The 551

Yardley Molded Plastics, Inc. 646
Yardley Plastic Company 814

Zapf, Charles & Co. 756
Zollinger, Albert, Inc. 756

940, 941

....1002
.... 503
.... 855
778, 779
.... 810

259–270
0A, 190B
.... 454
.... 790
530, 531

186, 187
....553

191–200
.... 462

.... 804
.... 308
.... 887

09–1012
.... 815
.... 764

942, 943
...812A
.... 806

.... 419
.... 418
.... 641
.... 637
....1000
.... 183

950, 951
.... 993
57, 493
.... 299
.... 815
.... 927
.... 920
970, 971
....1000
934, 935
.... 391
.... 258
918, 919
.... 551

.... 646
.... 814

.... 756
.... 756

MODERN PLASTICS

ENCYCLOPEDIA

ISSUE

SEPTEMBER

1957

BRADBURY